

# Native Spring Investigation Data Report

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# Naval Air Weapons Station China Lake

## FOREWORD

The research described in this report was performed at the Naval Air Weapons Station (NAWS) China Lake as part of a native springs investigation conducted during fiscal year (FY) 94. This report documents the data collection and results of water quality, geologic mapping, and aerial resistivity properties for each of 31 native springs investigated.

This work was performed in accordance with NAWS Contract No. N60530-90-D-0071, Delivery Order No. 0020. The results of this report were reviewed for technical accuracy by Thomas Campbell and are final in nature. This report is approved for public release with unlimited distribution.

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## CONTENTS

Introduction.....	3
Data Collection .....	3
Water Chemistry/Isotopic Composition .....	3
Resistivity Surveys .....	4
Geologic Maps .....	4
Appendixes:	
A. Water Chemistry Graphics .....	13
B. Spring Resistivity Surveys .....	33
C. Geologic Maps.....	57

## Figures:

1. China Lake Native Spring Study - North Range Index Map .....	7
2. China Lake Native Spring Study - South Range Index Map .....	8

## Tables:

1. Spring Site Work Accomplished.....	6
2. NAWS China Lake Native Spring Study Chemical Analysis .....	9

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## INTRODUCTION

A series of native springs in the Indian Wells Valley were investigated by the NAWS China Lake Environmental Project Office during FY94 to gather baseline geophysical and geological data. Thirty-one native springs (Table 1) located in the north and south test ranges (Figures 1 and 2) at NAWS China Lake were sampled for water quality. Air photographs of each spring site were taken for geohydrologic interpretation, and the location of each spring was surveyed for its aerial resistivity properties and geologic mapping.

Springs were selected for investigation by their importance as a water resource for the following:

1. Usage by facilities located in remote areas
2. Usage by grazing cattle in remote areas
3. Wildlife usage
4. Feral horse and burro usage

Results from this investigation will be used as a resource for the FY95 NAWS China Lake Spring Management Plan.

## DATA COLLECTION

### WATER CHEMISTRY/ISOTOPIC COMPOSITION

Water samples were collected from each native spring and analyzed for isotopic composition (oxygen 16:18 ratios, tritium, and deuterium), methylene blue active substances (MBAS), pH, specific conductance, total filterable residue, and general mineral content as follows:

- |                 |                |                   |
|-----------------|----------------|-------------------|
| •Aluminum       | •Arsenic       | •Barium           |
| •Bicarbonate    | •Boron         | •Bromide          |
| •Cadmium        | •Calcium       | •Carbonate        |
| •Chloride       | •Copper        | •Fluoride         |
| •Hydroxide      | •Iron          | •Lead             |
| •Lithium        | •Magnesium     | •Manganese        |
| •Mercury        | •Nitrates      | •Potassium        |
| •Selenium       | •Silica        | •Silver           |
| •Sodium         | •Sulfate       | •Total Alkalinity |
| •Total Anions   | •Total Cations | •Total Chromium   |
| •Total Hardness | •Zinc          |                   |

Field measurements of pH were recorded with a Hanna pH meter, calibrated at least twice a day using two standard reference solutions. Conductivity was measured with a YSI 3000 TLC meter, calibrated daily. Conductivity and pH readings measured in the field are more accurate representations of existing conditions because bacterial reactions in the sample bottles may occur, which can change the pH readings. A field thermometer was used to record the temperature of each native spring.

Water analyses are presented in Table 2. The important mineral species and isotope compositions of each native spring are graphically highlighted in Appendix A. Spring locations are identified by their assigned number (Table 1), and constituents are reported in milligrams per liter (mg/L). Maximum contaminant levels (MCL) are designated on mineral species with applicable state and federal standards.

## RESISTIVITY SURVEYS

Direct current resistivity measurements were completed at 10 spring locations to provide subsurface information that will aid in the interpretation of structural and geohydrologic features that may control the occurrence of each spring.

The surveys were completed with an ABEM Terrameter 300B and several standard electrode arrays. Gradient arrays were set at 800-foot-current electrode separations. A roving receiver dipole was used to map out the areas in between these separations. This array was useful as a "contact finder" in locating features such as basement dikes. Schlumberger depth soundings were used to investigate layering beneath a specific site, such as a water table. Schlumberger profiling was completed by moving a fixed-spacing array along a line of investigation, such as a canyon bottom.

Results of each survey are graphically described as "apparent resistivity" and as graphic symbols superimposed on aerial photographs of the springs. Notations from the survey are included on each graph, such as geographic locations and changes in rock and/or soil types. In the photographic presentations, the width of each profile symbol is proportional to resistivity, thus allowing the reader to correlate resistivity anomalies with features such as joints and faults that are not visible on the United States Geological Survey topographic maps. Plates displaying aerial photographs with resistivity lines superimposed on them are presented in Appendix B.

## GEOLOGIC MAPS

Depending on the individual characteristics and aerial extent of each spring, geologic maps were constructed using the following scales:

1. 1 inch equals 50 feet
2. 1 inch equals 100 feet
3. 1 inch equals 150 feet
4. 1 inch equals 200 feet

Aerial stereographic and ground photographs were used in mapping each spring site. The negative scales for the types of films used are as follows:

1. Stereo-imagery in false-color infrared flown at low altitudes: 1 inch equals 300 feet.
2. True-color aerial color film at slightly higher altitudes: 1 inch equals 600 feet.
3. High-altitude false-color photographs: 1 inch equals 1600 feet.

These high-altitude prints, which became available late in the investigation, were extremely useful in providing a more even exposure in areas of steep slopes and deep canyons as a result of higher sun angles.

Each photograph was enlarged with a laser color copier for field use and a digital scanner for computer work. Raster images were overlaid onto the digitized topography to furnish the correct scale and location. These combined ground and photographic interpretations were computer drafted using AutoCad Version 12 and CadOverlay GSX Version 2 to provide a final drawing of each spring site. The geologic maps are listed alphabetically by spring name in Appendix C.

TABLE 1. Spring Site Work Accomplished.

Spring no.	Spring name	Chemical analyses	Resistivity survey	Air photos	Geologic maps
1.	Amity	x	x	x	x
2.	Bircham	x	x	x	x
3.	China Gardens	x		x	x
4.	Cole	x	x	x	x
5.	Crystal	x	x	x	x
6.	Darwin	x		x	x
7.	Dead End	x		x	x
8.	Granite Wells	x		x	x
9.	Haiwee	x		x	
10.	Hidden	x		x	x
11.	Indian	x		x	x
12.	Indian Gardens	x	x	x	x
13.	Lamotte	x		x	x
14.	Layton	x		x	x
15.	Lead Pipe	x	x	x	x
16.	Mammoth Mine	x		x	x
17.	Margaret Ann	x		x	x
18.	Mariposa	x	x	x	x
19.	Mesquite	x		x	x
20.	Myrick	x		x	
21.	Newhouse	x	x	x	x
22.	N. Mountain Springs	x		x	x
23.	Old House	x	x	x	x
24.	Pink Hill	x		x	x
25.	Rudy	x		x	x
26.	Seep	x		x	x
27.	Stone Corral	x		x	x
28.	Tennessee	x	x	x	x
29.	Upper Tunnel	x		x	x
30.	Wild Rose	x		x	x
31.	Wilson Canyon	x		x	x



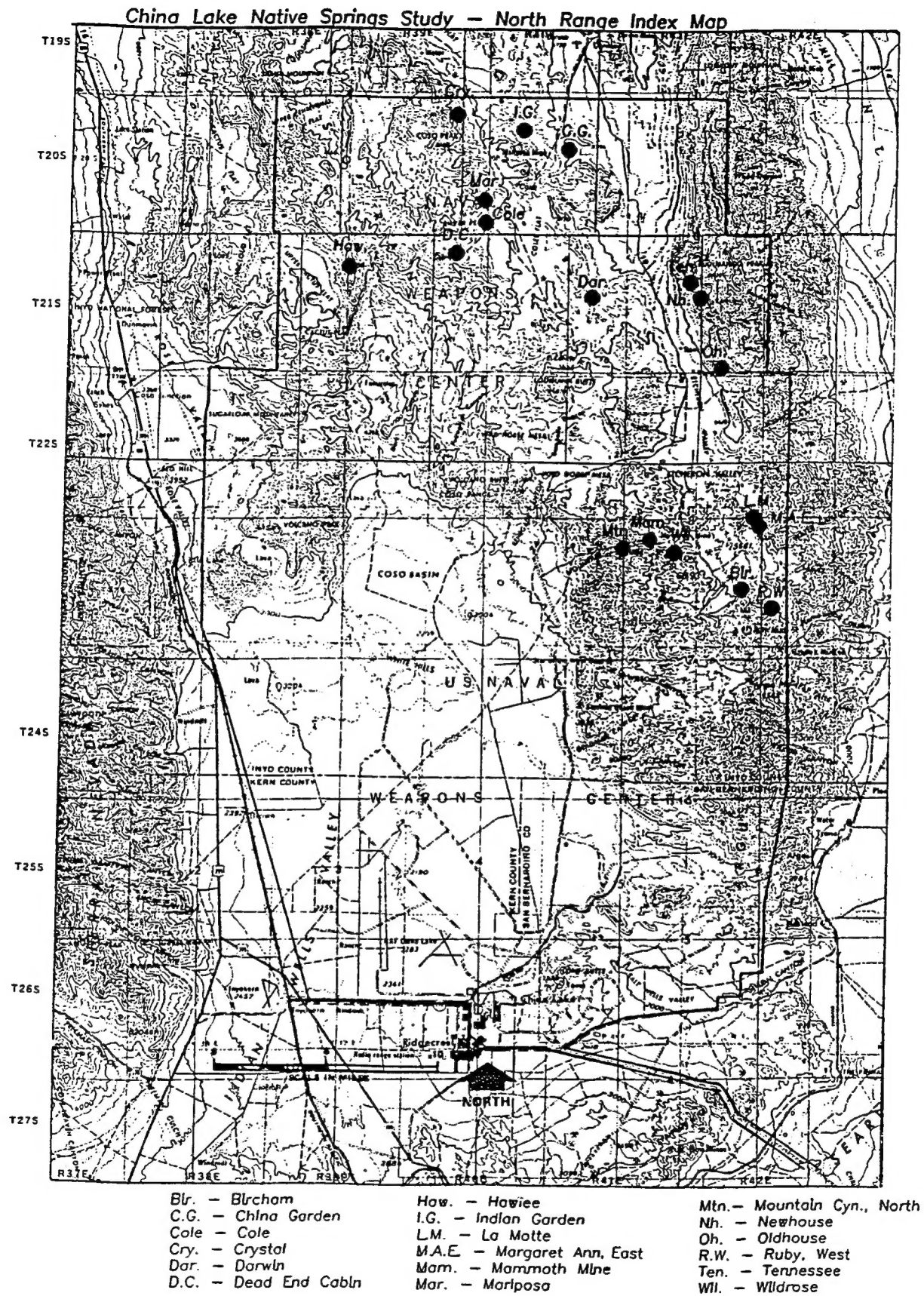


FIGURE 1. China Lake Native Spring Study - North Range Index Map.

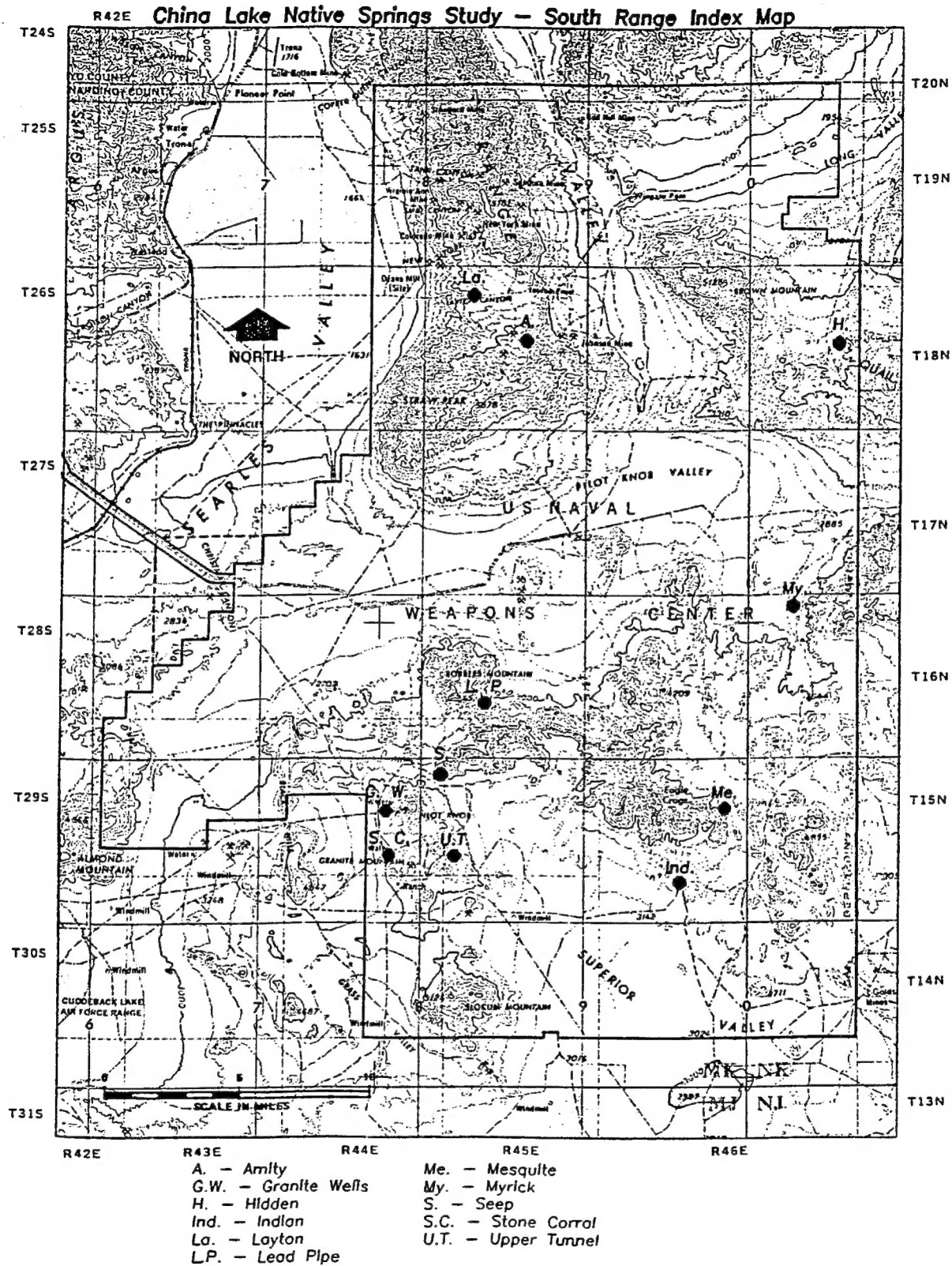


FIGURE 2. China Lake Native Spring Study - South Range Index Map.

TABLE 2. NAWS China Lake Native Spring Study Chemical Analyses.

CHEMICAL ANALYSES		China Lake/NAWS Native Spring Study									
Species Analyses	Units	Amity	Bircham	China Garden	Cole	Crystal	Darvin	Dead End	Granite	Halvce	Hidden
Aluminum (Al)	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Arsenic (As)	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.012
Barium (Ba)	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Bicarbonate (HCO <sub>3</sub> )	mg/L	336	238	107	183	137	183	250	244	153	207
Boron (B)	mg/L	0.3	0.2	0.2	<0.1	<0.1	0.1	0.2	0.3	<0.1	0.4
Bromide (Br)	mg/L	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cadmium (Cd)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Calcium (Ca)	mg/L	93	52	49	143	66	83	61	65	33	50
Carbonate (CO <sub>3</sub> )	mg/L	0	0	0	0	0	0	0	0	0	0
Chloride (Cl)	mg/L	75	27	32	38	50	33	23	42	15	51
Copper (Cu)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluoride (F)	mg/L	1.1	0.2	0.1	0.2	0.1	0.2	0.3	0.7	0.4	0.8
Hydroxide (OH)	mg/L	0	0	0	0	0	0	0	0	0	0
Iron (Fe)	mg/L	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Lead (Pb)	mg/L	<0.005	<0.005	<0.005	<0.005	0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Lithium (Li)	mg/L	0.02	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	0.03	<0.01	0.03
Magnesium (Mg)	mg/L	31	14	15	46	11	15	12	9	16	16
Manganese (Mn)	mg/L	<0.01	0.02	<0.01	<0.01	0.03	<0.01	0.13	<0.01	<0.01	0.05
NIRAS	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Mercury (Hg)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nitrate (NO <sub>3</sub> )	mg/L	24	8	6	4	1	4	<1	37	<1	42
pH - lab	pH units	7.8	8.0	8.0	7.5	7.8	7.8	7.4	7.9	7.8	7.9
pH - field	pH units	7.5	7.4	7.7	7.2	7.4	7.2	6.8	7.3	7.8	7.4
Potassium (K)	mg/L	3	3	6	4	5	3	2	2	3	7
Selenium (Se)	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Silica (SiO <sub>2</sub> )	mg/L	36	32	41	30	30	41	36	58	60	73
Silver (Ag)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium (Na)	mg/L	61	28	32	40	18	35	33	59	27	59
Specific Conductance - lab	µmho/cm	880	460	520	1080	520	670	500	680	410	630
Specific Conductance - field	µmho/cm	962	480	493	1155	521	675	537	676	418	678
Sulfate (SO <sub>4</sub> )	mg/L	100	19	120	430	67	140	40	53	63	57
Total Alkalinity as CaCO <sub>3</sub>	mg/L	275	195	88	150	113	150	205	200	135	170
Total Anions	me/L	10.14	5.20	5.25	13.10	5.08	6.92	5.60	6.92	4.25	6.75
Total Cations	me/L	9.96	5.07	5.24	12.82	5.13	7.00	5.53	6.62	4.28	6.58
Total Chromium (Cr)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Filterable Residue	mg/L	610	295	375	820	315	520	330	440	285	455
Total Hardness as CaCO <sub>3</sub>	mg/L	362	188	185	549	211	270	203	200	149	192
Zinc (Zn)	mg/L	<0.01	<0.01	<0.01	0.01	<0.01	0.02	0.04	<0.01	<0.01	<0.01
Isotope Analyses											
Tritium	T units	1.0	<1.7	<0.7	<1.1	<0.7	0.7	1.4	<1.2	1.4	<1.5
Statistical significance											
Deuterium	%SMOW	-82	-91	-98	App. 0.4	-103	±0.3	±0.4	App. 0.6	±0.4	-84
Oxygen 18	%SMOW	-11.5	-12.1	-13.0	-94	-13.9	-13.2	-12.7	-83	-13.2	-9.8

TABLE 2. (Contd.)

## CHEMICAL ANALYSES

Species Analyses	Units	Indian	Indian Garden	La Motte	Layton	Lead Pipe	Mammoth Mine	China Lake NAWS Native Spring Study				
								Margaret Ann - E.	Mariposa	Mesquite	Myrick	
Aluminum (Al)	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	
Arsenic (As)	mg/L	<0.005	<0.005	<0.005	<0.005	0.018	<0.005	<0.005	0.013	<0.005	0.11	
Barium (Ba)	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	
Bicarbonate (HCO <sub>3</sub> )	mg/L	107	122	290	366	122	302	427	326	153	1530	
Boron (B)	mg/L	0.2	0.2	<0.1	2.7	0.3	0.2	0.4	0.1	0.1	3.6	
Bromide (Br)	mg/L	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
Cadmium (Cd)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	<0.001	<0.001	<0.001	
Calcium (Ca)	mg/L	18	68	67	114	26	64	175	255	35	10	
Carbonate (CO <sub>3</sub> )	mg/L	0	0	0	0	0	0	0	0	0	0	
Chloride (Cl)	mg/L	26	32	36	200	37	40	64	54	26	78	
Copper (Cu)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	
Fluoride (F)	mg/L	0.3	0.2	0.4	1.6	0.5	0.3	0.8	0.4	0.4	8.2	
Hydroxide (OH)	mg/L	0	0	0	0	0	0	0	0	0	0	
Iron (Fe)	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	1.8	
Lead (Pb)	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.006	
Lithium (Li)	mg/L	0.02	<0.01	<0.01	0.06	0.06	<0.01	0.01	<0.01	0.02	0.11	
Magnesium (Mg)	mg/L	9	18	18	40	4	16	45	46	8	3	
Manganese (Mn)	mg/L	<0.01	<0.01	0.03	<0.01	<0.01	0.43	<0.01	0.11	<0.01	0.18	
NBAS	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	
Mercury (Hg)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
Nitrate (NO <sub>3</sub> )	mg/L	22	<1	<1	25	13	<1	<1	<1	<1	<1	
pH - lab	pH units	7.8	7.8	8.1	7.7	7.7	7.7	7.8	7.4	7.7	8.8	
pH - field	pH units	8.1	7.5	8.0	7.4	7.0	7.4	7.7	6.9	7.4	8.4	
Potassium (K)	mg/L	7	6	2	2	6	6	4	4	6	24	
Selenium (Se)	mg/L	<0.005	<0.005	<0.005	0.006	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	
Silica (SiO <sub>2</sub> )	mg/L	100	36	41	32	103	32	42	64	92	66	
Silver (Ag)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
Sodium (Na)	mg/L	36	39	38	222	55	47	95	45	36	860	
Specific Conductance - lab	µmho/cm	340	670	560	1510	420	600	1400	1530	420	3300	
Specific Conductance - field	µmho/cm	362	672	636	1188	449	673	1449	1557	427	3450	
Sulfate (SO <sub>4</sub> )	mg/L	30	190	41	330	46	43	390	560	27	250	
Total Alkalinity as CaCO <sub>3</sub>	mg/L	88	100	238	300	100	248	350	268	125	1390	
Total Anions	me/L	3.48	6.87	6.63	18.99	4.24	7.00	16.97	18.56	4.28	38.97	
Total Cations	me/L	3.40	6.75	6.55	18.73	4.17	6.72	16.73	18.64	4.14	38.76	
Total Chloronium (Cr)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
Total Filterable Residue	mg/L	300	500	390	1130	355	395	1010	1360	330	2520	
Total Hardness as CaCO <sub>3</sub>	mg/L	83	245	243	452	82	227	625	829	121	38	
Zinc (Zn)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	0.07	
Isotope Analyses												
Tritium	T. units	1.0	<1.1	<1.0	3.1	0.9	<1.1	2.9	0.9	0.8	<0.8	
Statistical significance		±0.4	App. 0.4	App. 0.4	±0.4	±0.4	App. 0.4	±0.4	±0.3	±0.4		
Deuterium	%SMOW	-90	-94	-90	-83	-93	-85	-84	-95	-84	-95	
Oxygen 18	%SMOW	-12.4	-12.9	-12.0	-10.1	-12.1	-10.8	-11.3	-12.9	-10.5	-11.9	

TABLE 2. (Contd.)

CHEMICAL ANALYSES

China Lake NAWS Native Spring Study

Species Analyses	Units	New House	North Mountain	Old House	Pink Hill	Ruby - west	Seep	Stone Corral	Tennessee	Upper Tunnel
Aluminum (Al)	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Arsenic (As)	mg/L	<0.005	<0.005	<0.005	0.006	<0.005	0.016	<0.005	<0.005	<0.005
Barium (Ba)	mg/L	<0.1	<0.1	<0.1	<0.1	0.3	<0.1	<0.1	<0.1	<0.1
Bicarbonate (HCO3)	mg/L	137	439	183	174	357	76	195	153	183
Boron (B)	mg/L	<0.1	0.6	<0.1	0.3	0.3	0.3	0.2	<0.1	0.1
Bromide (Br)	mg/L	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cadmium (Cd)	mg/L	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001
Calcium (Ca)	mg/L	44	113	59	3	86	21	69	51	72
Carbonate (CO3)	mg/L	0	0	0	0	0	0	0	0	0
Chloride (Cl)	mg/L	14	93	16	37	56	24	33	26	41
Copper (Cu)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluoride (F)	mg/L	<0.1	0.4	0.1	0.4	0.2	0.5	0.6	0.2	0.6
Hydroxide (OH)	mg/L	0	0	0	0	0	0	0	0	0
Iron (Fe)	mg/L	<0.02	0.04	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Lead (Pb)	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Lithium (Li)	mg/L	<0.01	<0.01	<0.01	0.09	<0.01	0.02	0.01	<0.01	0.02
Magnesium (Mg)	mg/L	4	30	9	<1	17	4	8	5	11
Manganese (Mn)	mg/L	<0.01	0.22	<0.01	0.01	0.06	<0.01	<0.01	<0.01	<0.01
NH4AS	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
Mercury (Hg)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nitrate (NO3)	mg/L	2	<1	<1	19	<1	16	46	<1	54
pH - lab	pH units	8.1	7.7	8.2	8.1	7.4	8.1	8.0	8.0	7.9
pH - field	pH units	7.6	7.3	7.8	7.3	7.3	7.7	7.4	7.7	7.5
Potassium (K)	mg/L	2	8	1	4	2	6	<1	3	2
Selenium (Se)	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Silica (SiO2)	mg/L	21	47	24	64	55	109	45	24	32
Silver (Ag)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium (Na)	mg/L	17	83	19	112	47	37	40	24	43
Specific Conductance - lab	µmho/cm	330	1040	440	480	720	340	600	420	670
Specific Conductance - field	µmho/cm	354	1128	443	520	157	346	614	427	667
Sulfate (SO4)	mg/L	35	110	54	39	19	44	61	51	76
Total Alkalinity as CaCO3	mg/L	113	360	150	143	293	63	160	125	150
Total Anions	me/L	3.40	12.13	4.58	5.03	7.84	3.14	6.17	4.30	6.63
Total Cations	me/L	3.32	11.97	4.56	5.12	7.81	3.14	5.86	4.09	6.44
Total Chromium (Cr)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Filterable Residue	mg/L	210	750	275	355	450	305	395	260	415
Total Hardness as CaCO3	mg/L	127	408	185	8	286	69	206	148	226
Zinc (Zn)	mg/L	0.04	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.030
Isotope Analyses										
Trillium	T. units	<0.7	1.4	<1.3	<0.7	<1.4	<1.1	<1.8	<1.1	0.9
Statistical significance										
Deuterium	‰SMOW	-97	±0.3	App. 0.6	-89	App. 0.6	App. 0.4	App. 0.9	App. 0.5	±0.4
Oxygen 18	‰SMOW	-13.3	-11.9	-13.0	-11.8	-12.3	-11.6	-82	-97	-76
								-11.2	-13.6	-8.9



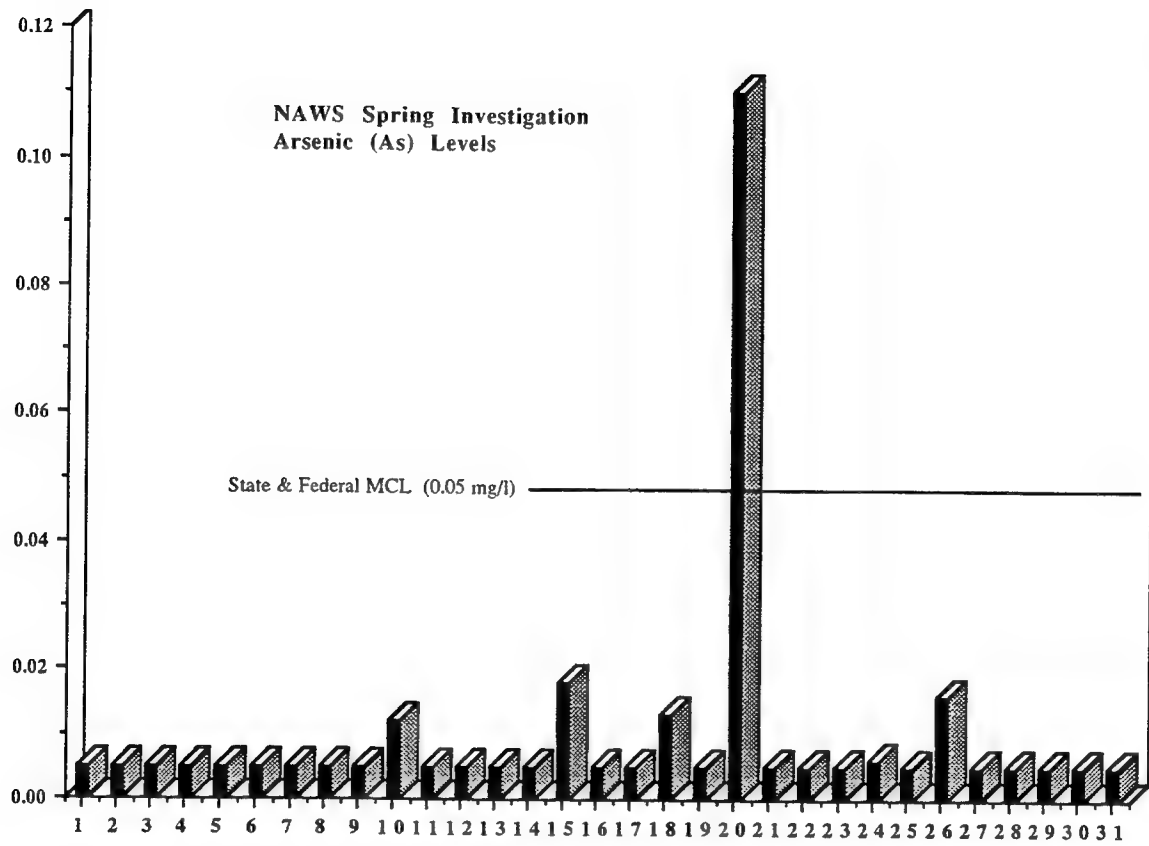
TABLE 2. (Contd.)

China Lake NAWS Native Spring Study

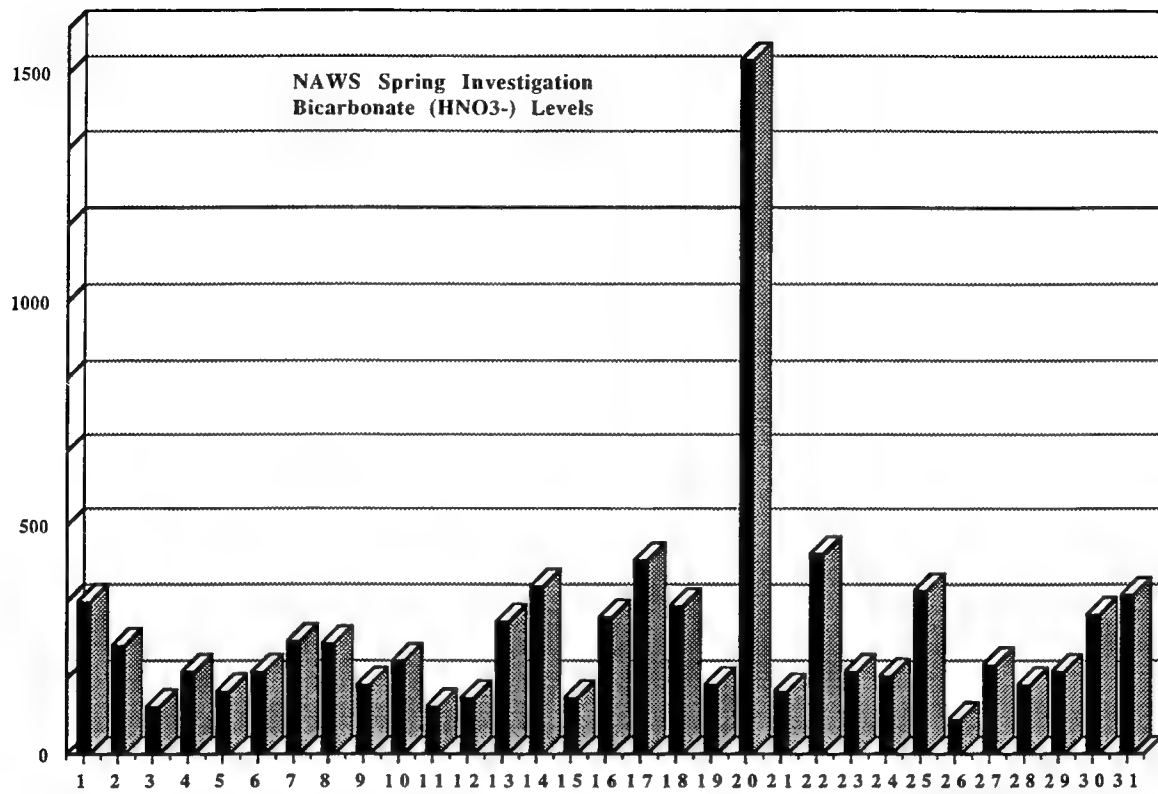
## CHEMICAL ANALYSES

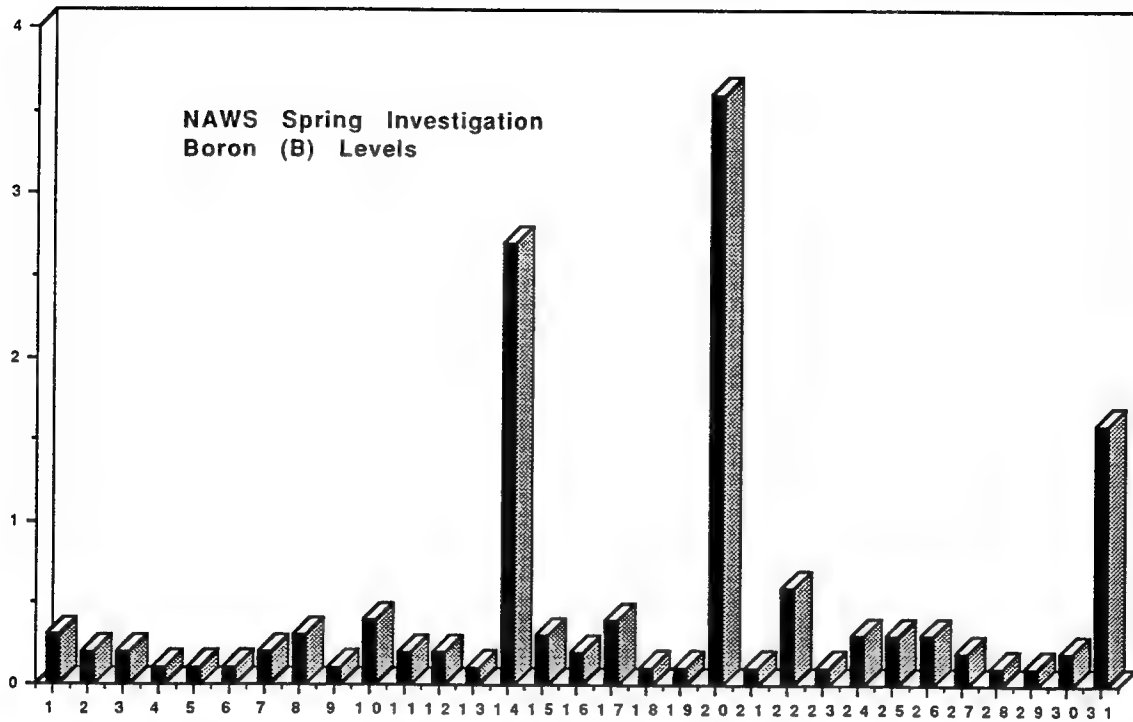
Species Analyses	Units	Wildrose Mine	Wilson
Aluminum (Al)	mg/L	<0.05	<0.05
Arsenic (As)	mg/L	<0.005	<0.005
Barium (Ba)	mg/L	<0.1	<0.1
Bicarbonate (HCO <sub>3</sub> )	mg/L	305	348
Boron (B)	mg/L	0.2	1.6
Bromide (Br)	mg/L	<1	<1
Cadmium (Cd)	mg/L	<0.001	<0.001
Calcium (Ca)	mg/L	78	112
Carbonate (CO <sub>3</sub> )	mg/L	0	0
Chloride (Cl)	mg/L	42	260
Copper (Cu)	mg/L	<0.01	<0.01
Fluoride (F)	mg/L	0.3	0.6
Hydroxide (OH)	mg/L	0	0
Iron (Fe)	mg/L	<0.02	<0.02
Lead (Pb)	mg/L	<0.005	<0.005
Lithium (Li)	mg/L	<0.01	<0.01
Magnesium (Mg)	mg/L	18	43
Manganese (Mn)	mg/L	0.02	<0.01
NIBAS	mg/L	<0.05	<0.05
Mercury (Hg)	mg/L	<0.001	<0.001
Nitrate (NO <sub>3</sub> )	mg/L	2	4
pH - lab	pH units	7.9	8.1
pH - field	pH units	7.3	8.0
Potassium (K)	mg/L	2	6
Selenium (Se)	mg/L	<0.005	<0.005
Silica (SiO <sub>2</sub> )	mg/L	36	49
Silver (Ag)	mg/L	<0.01	<0.01
Sodium (Na)	mg/L	35	160
Specific Conductance - lab	µmho/cm	520	1450
Specific Conductance - field	µmho/cm	670	1600
Sulfate (SO <sub>4</sub> )	mg/L	43	160
Total Alkalinity as CaCO <sub>3</sub>	mg/L	250	285
Total Anions	me/L	7.13	16.44
Total Cations	me/L	6.97	16.28
Total Chromium (Cr)	mg/L	<0.01	<0.01
Total Filterable Residue	mg/L	385	1080
Total Hardness as CaCO <sub>3</sub>	mg/L	270	459
Zinc (Zn)	mg/L	<0.01	<0.01
Isotope Analyses			
Trifluor	T. units	1.7	1.8
Deuterium	‰SNOW	±0.5	±0.4
Oxygen 18	‰SNOW	-92	-85
		-12.5	-10.7

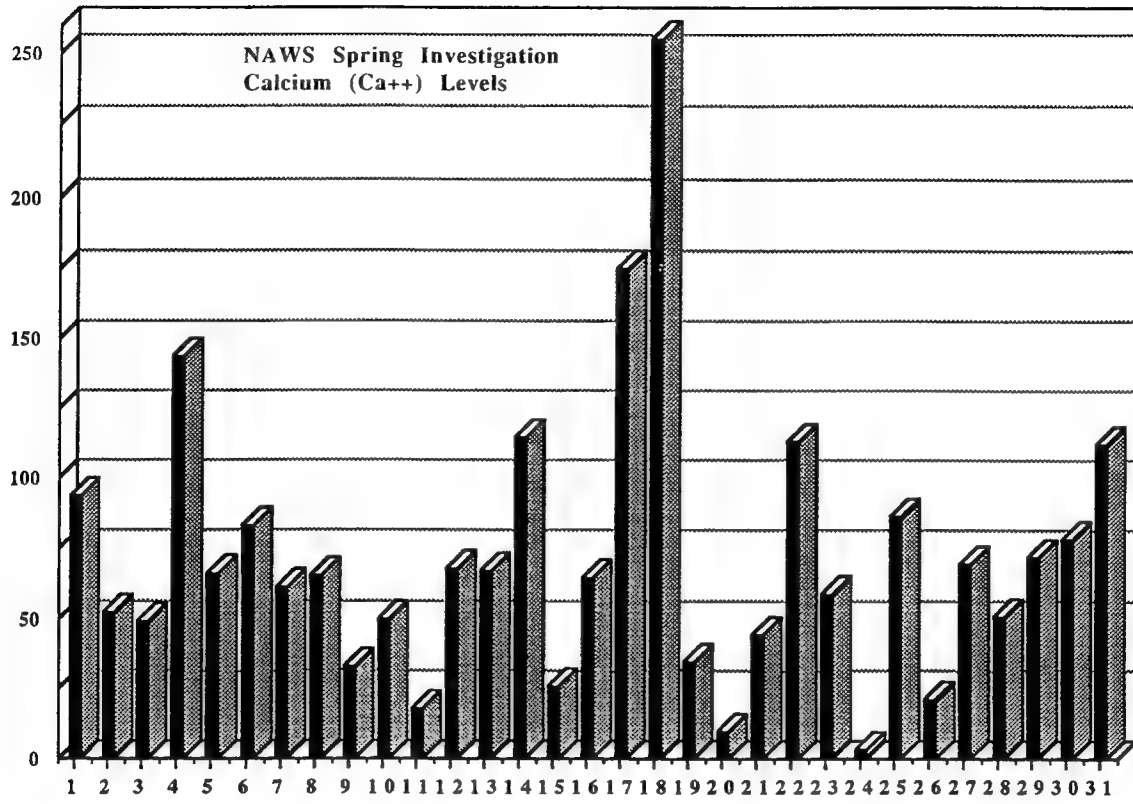
Appendix A  
WATER CHEMISTRY GRAPHICS

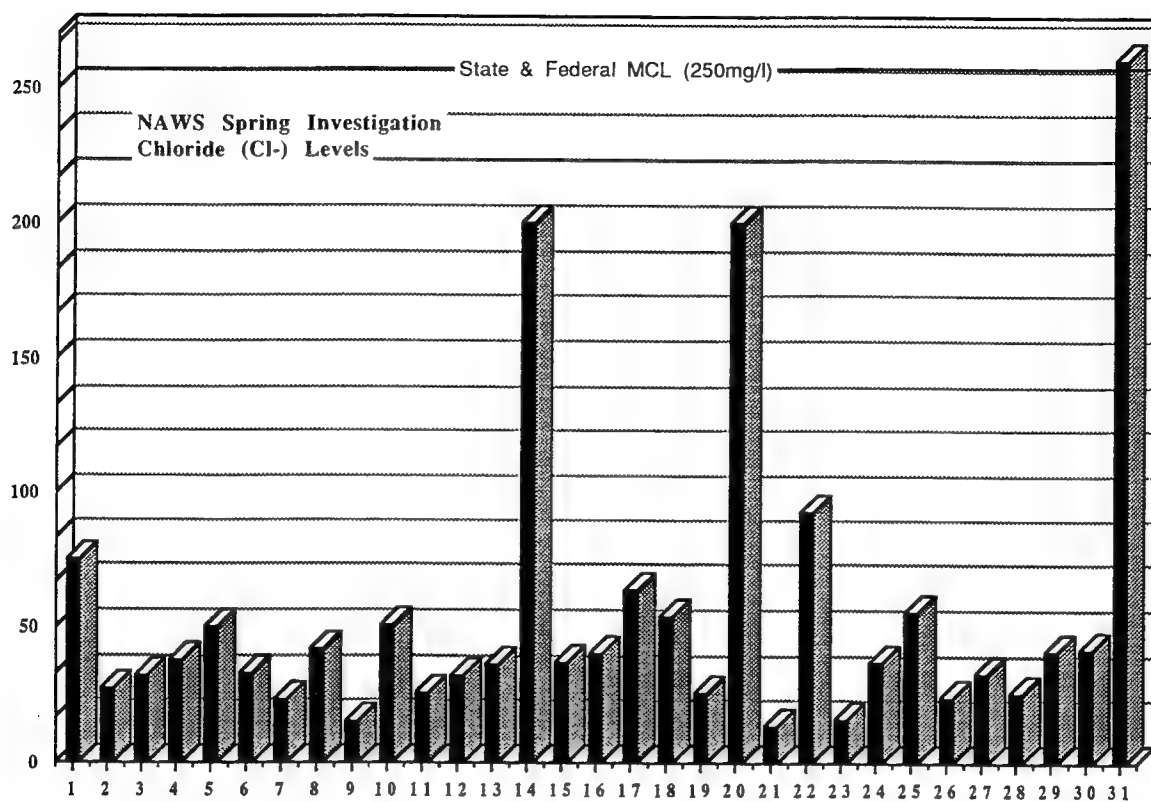


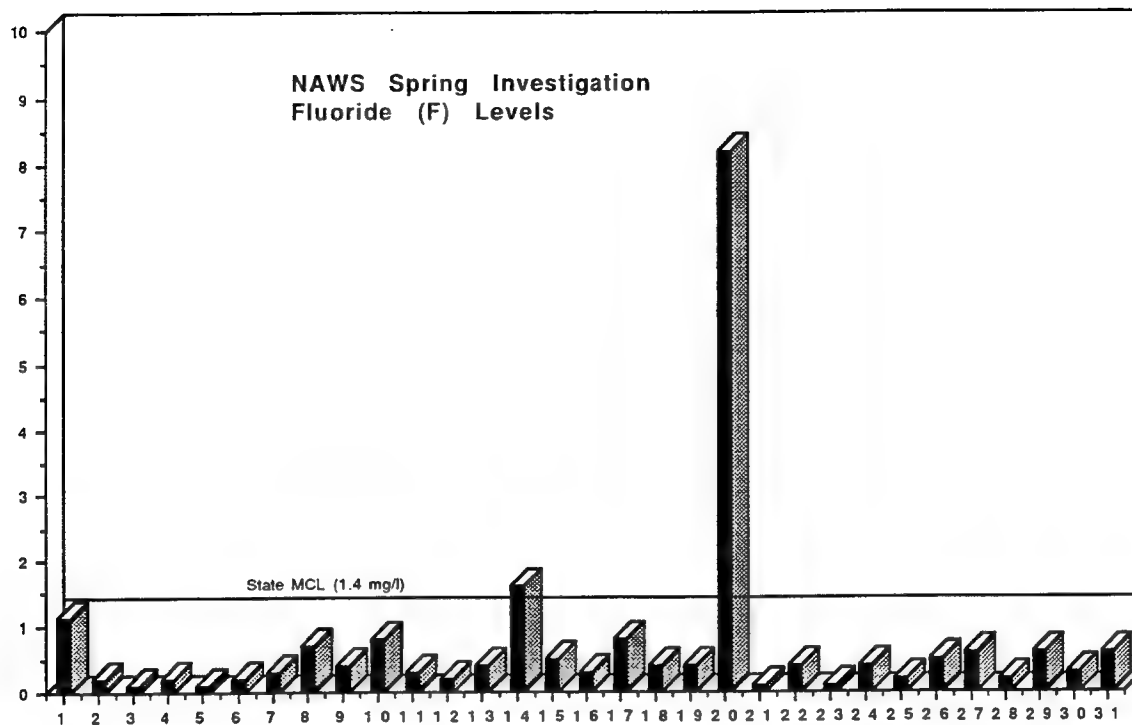


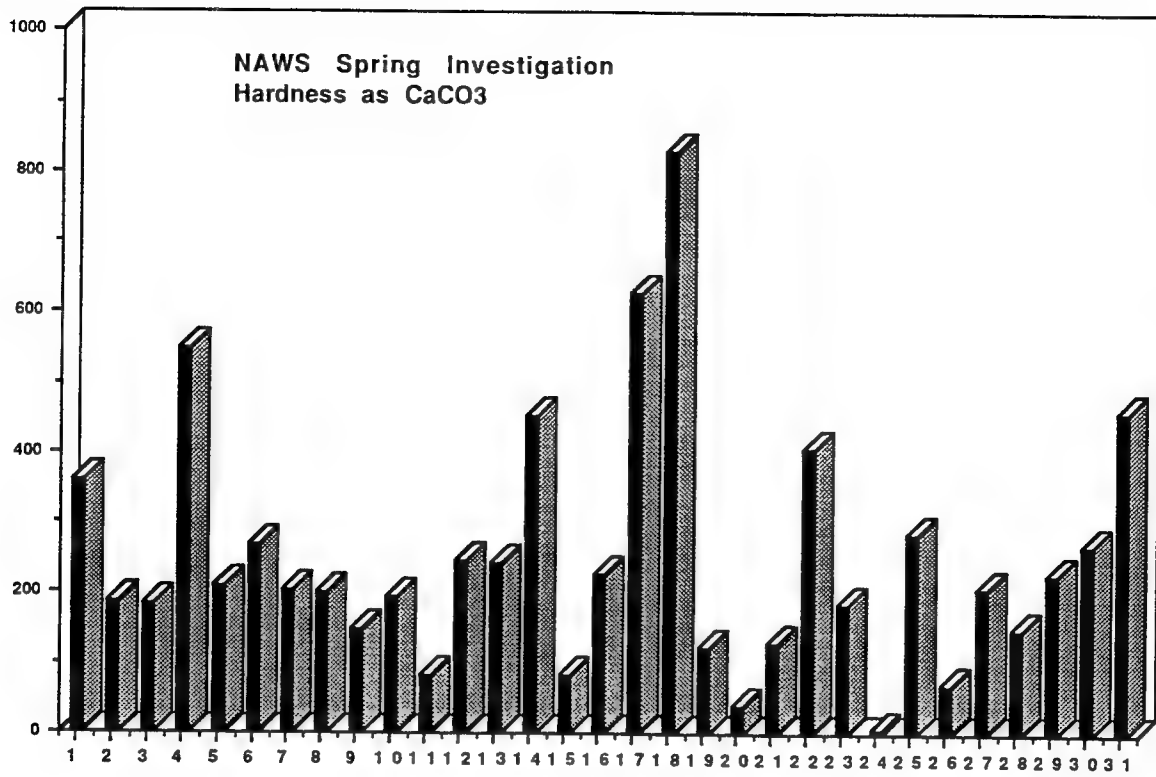


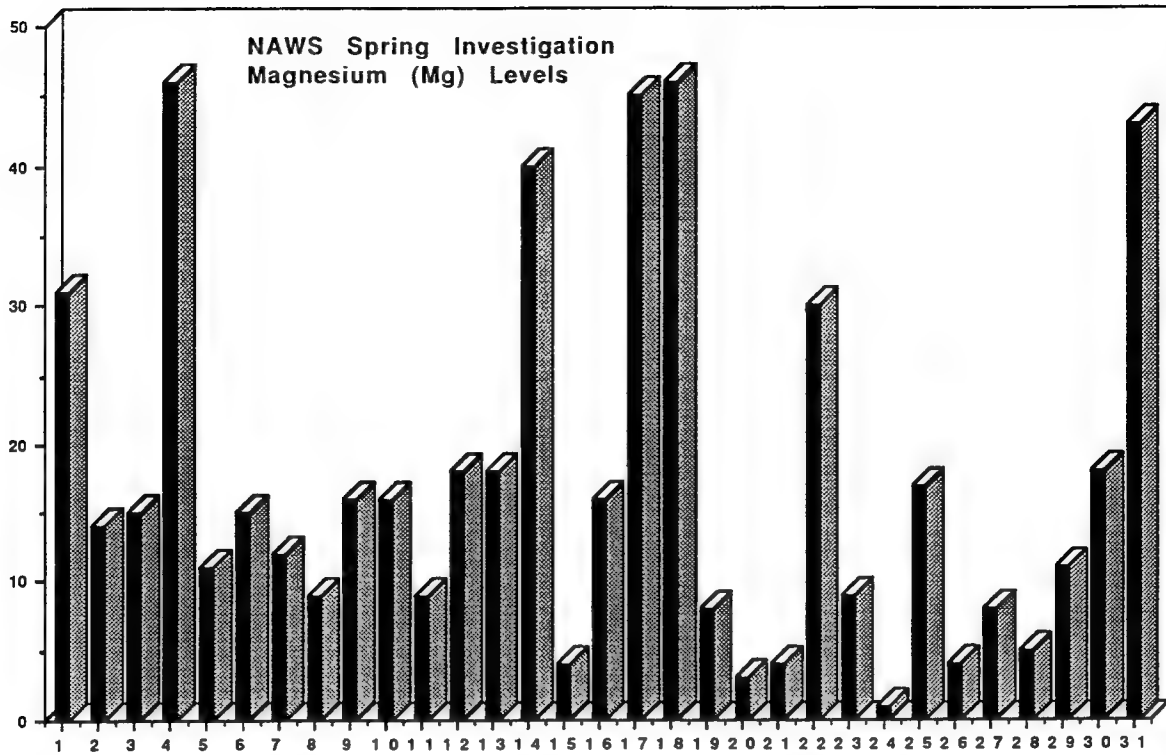


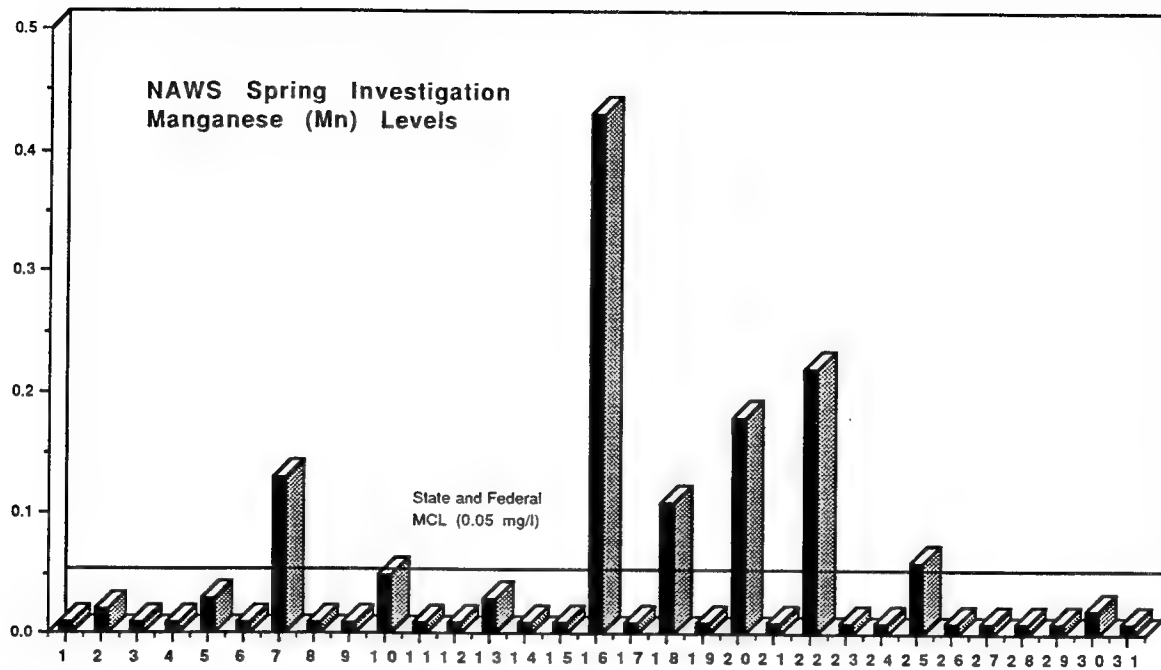




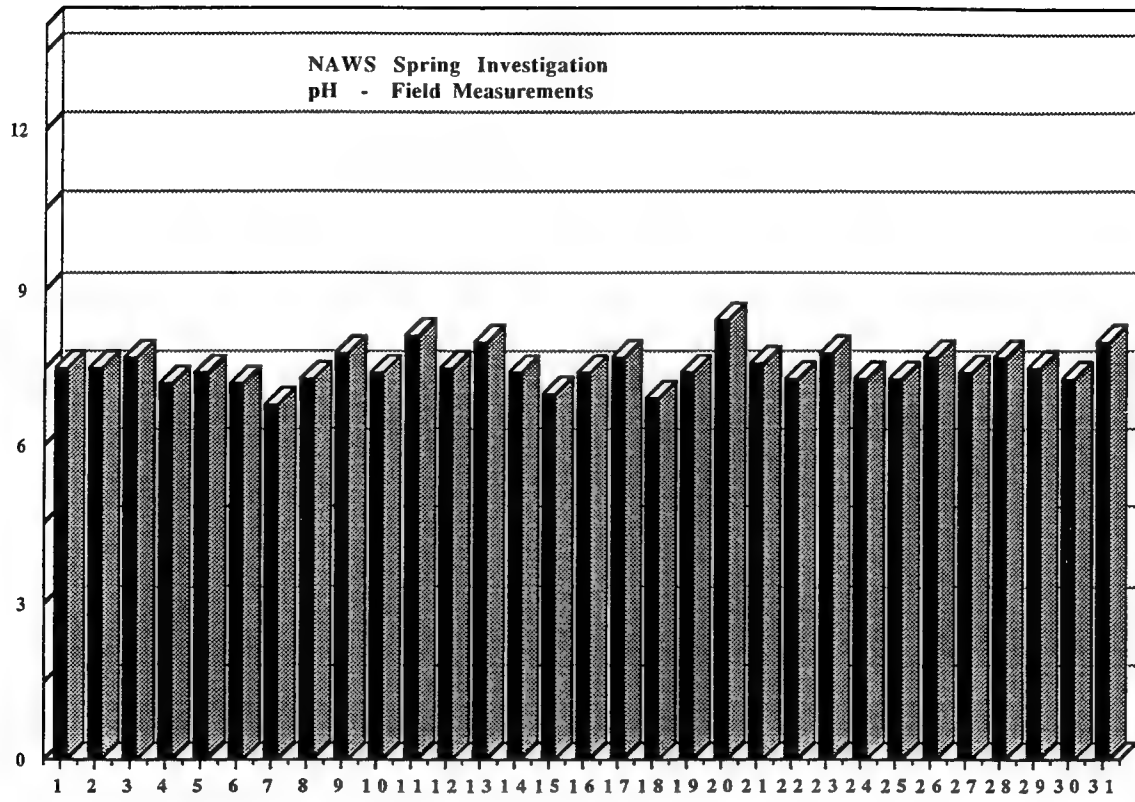


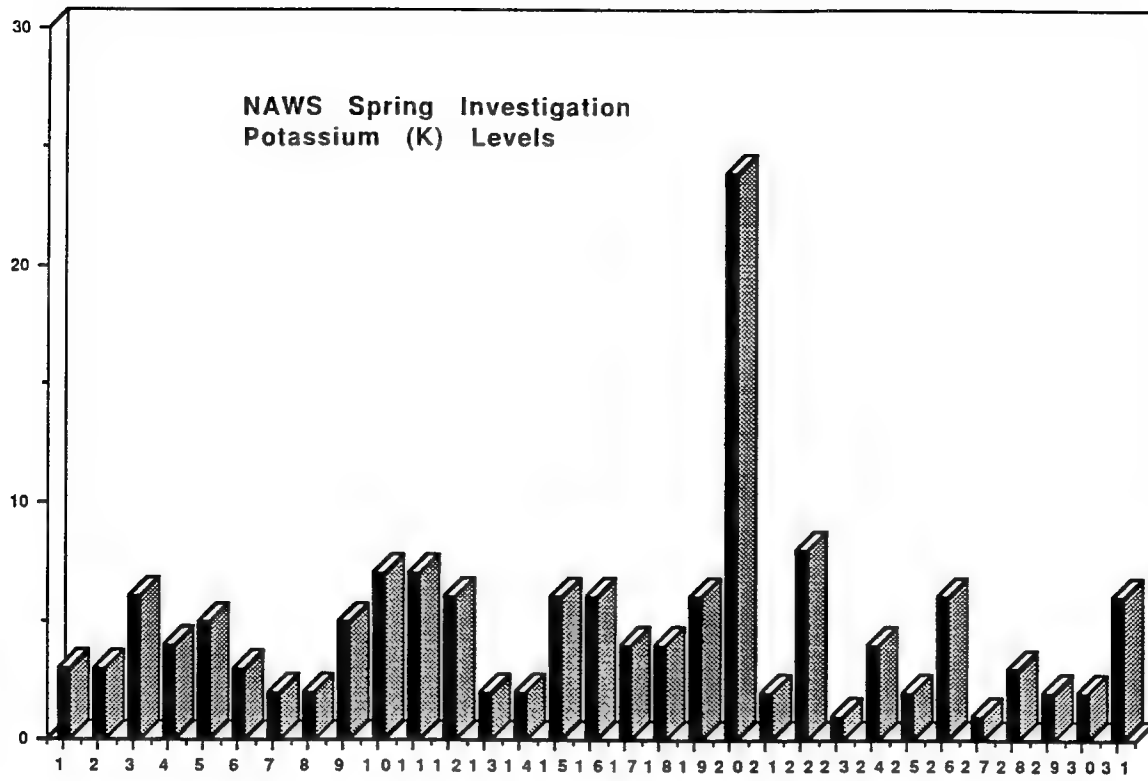


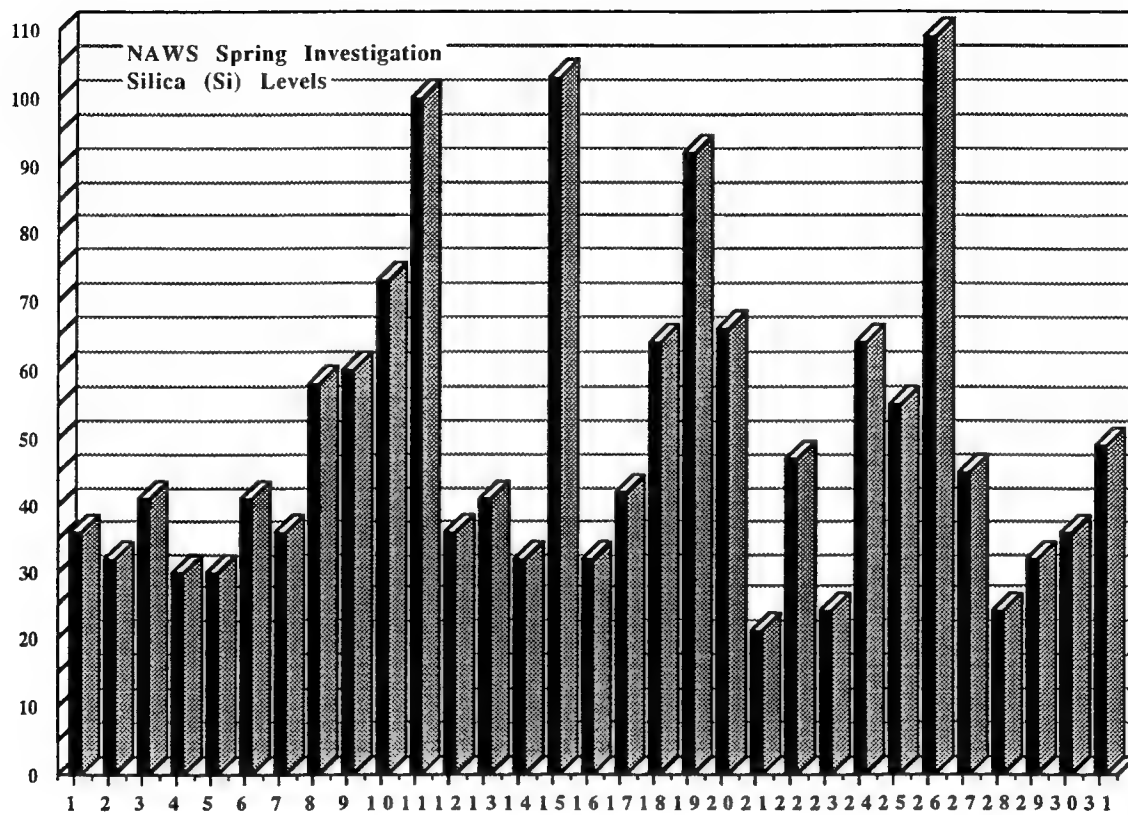


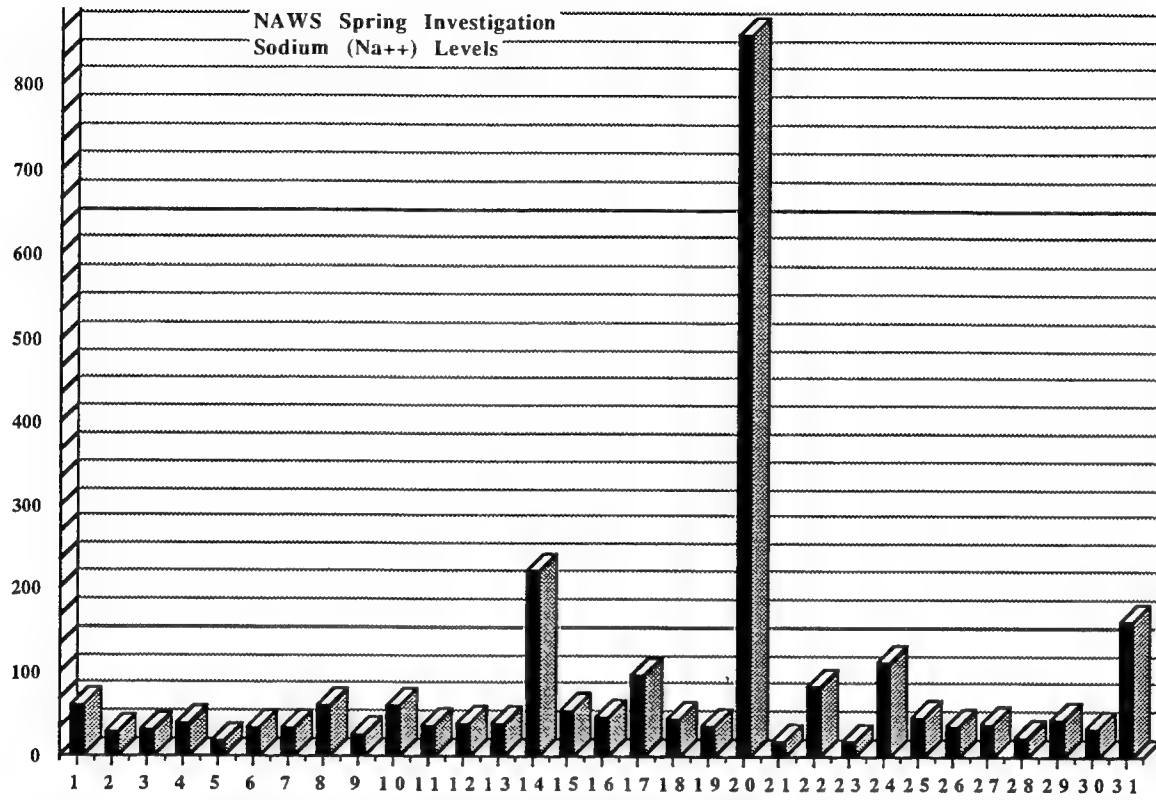


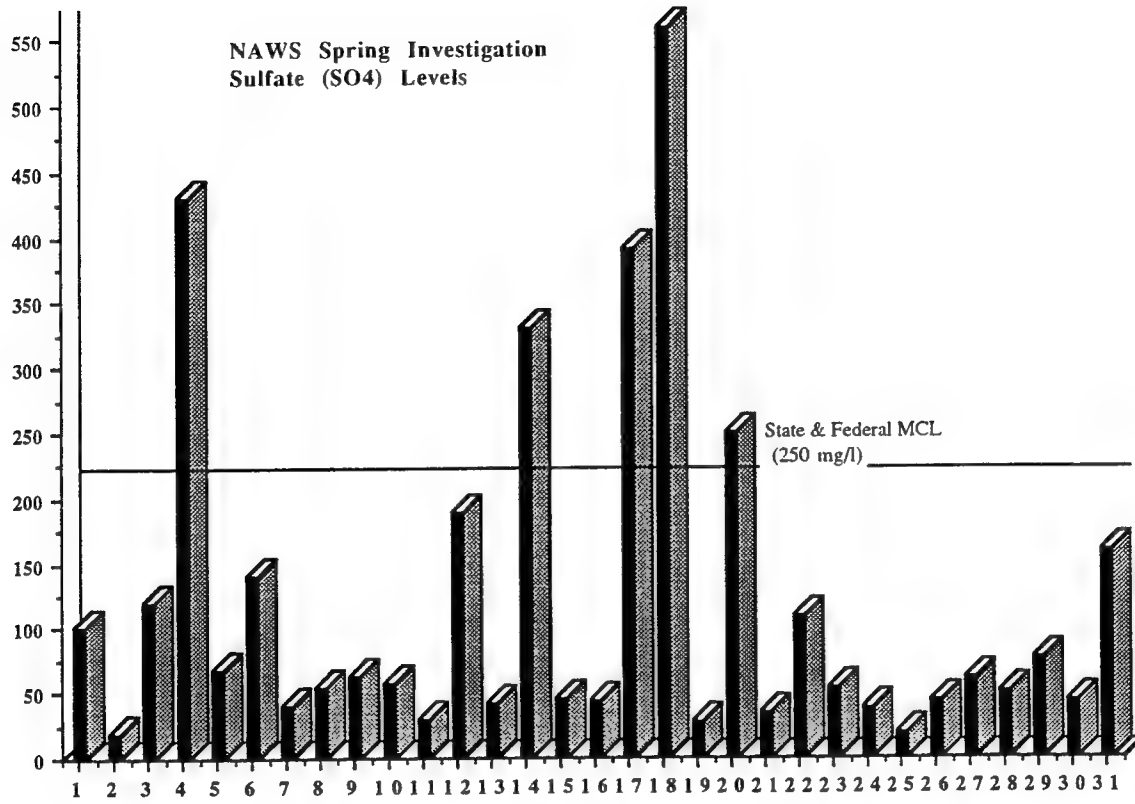


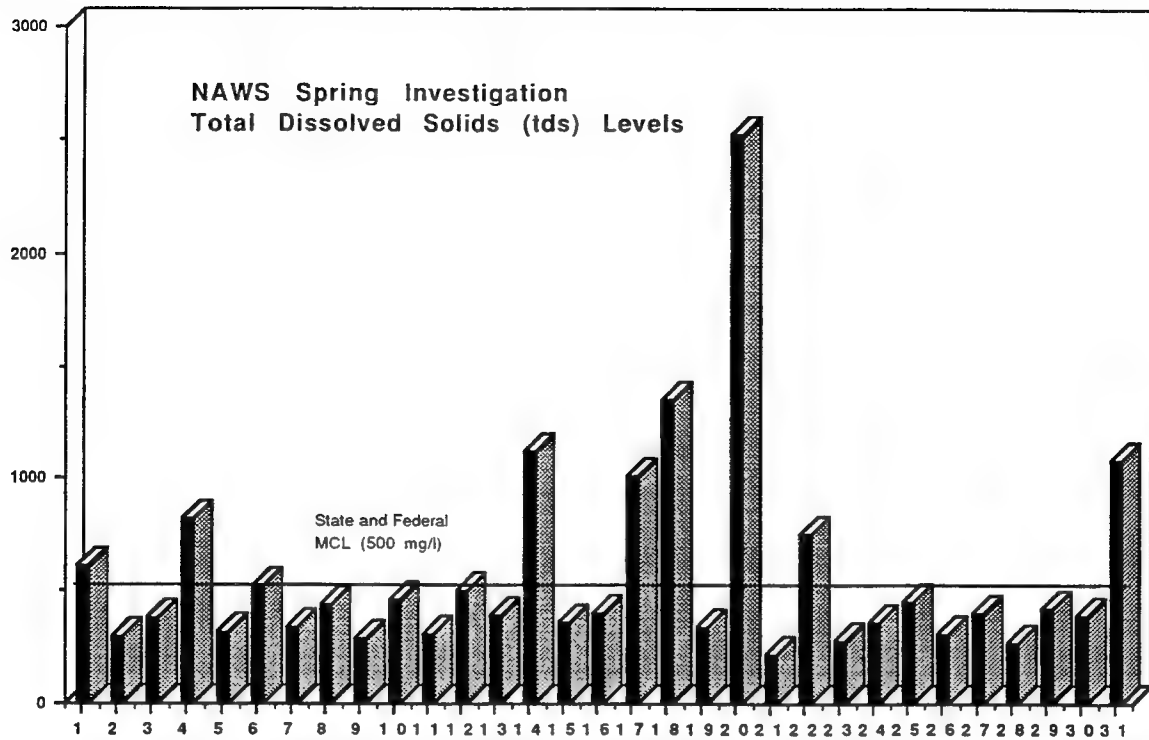


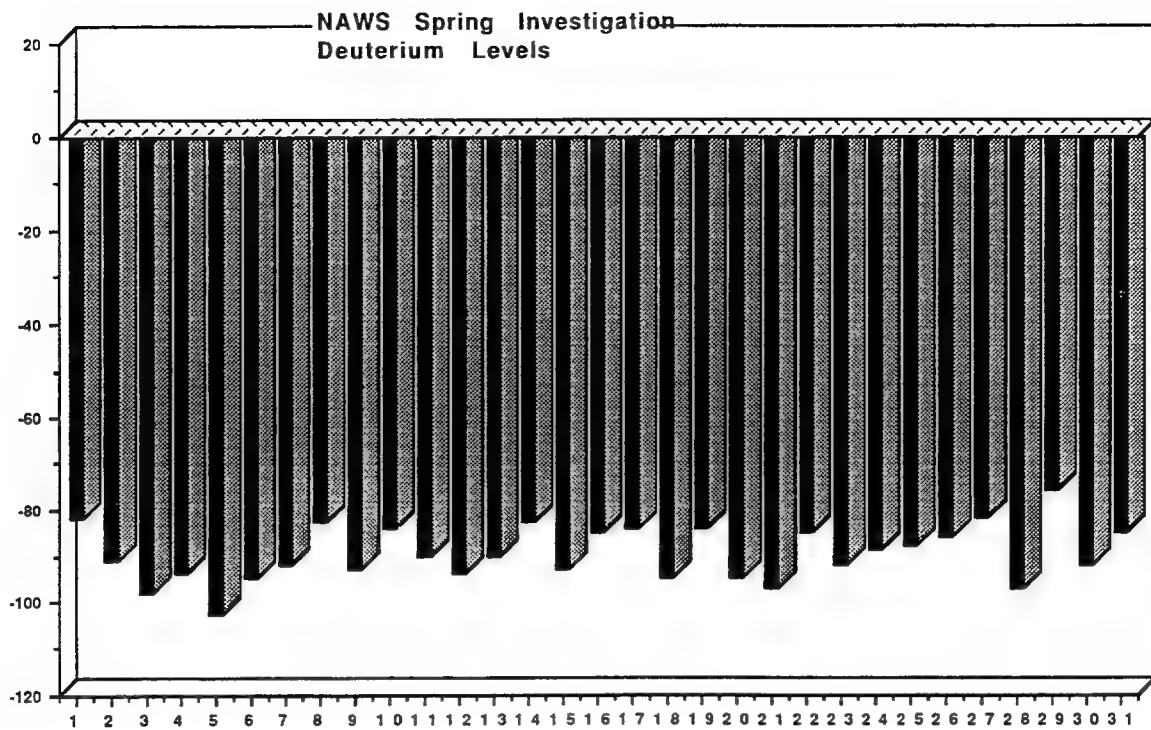


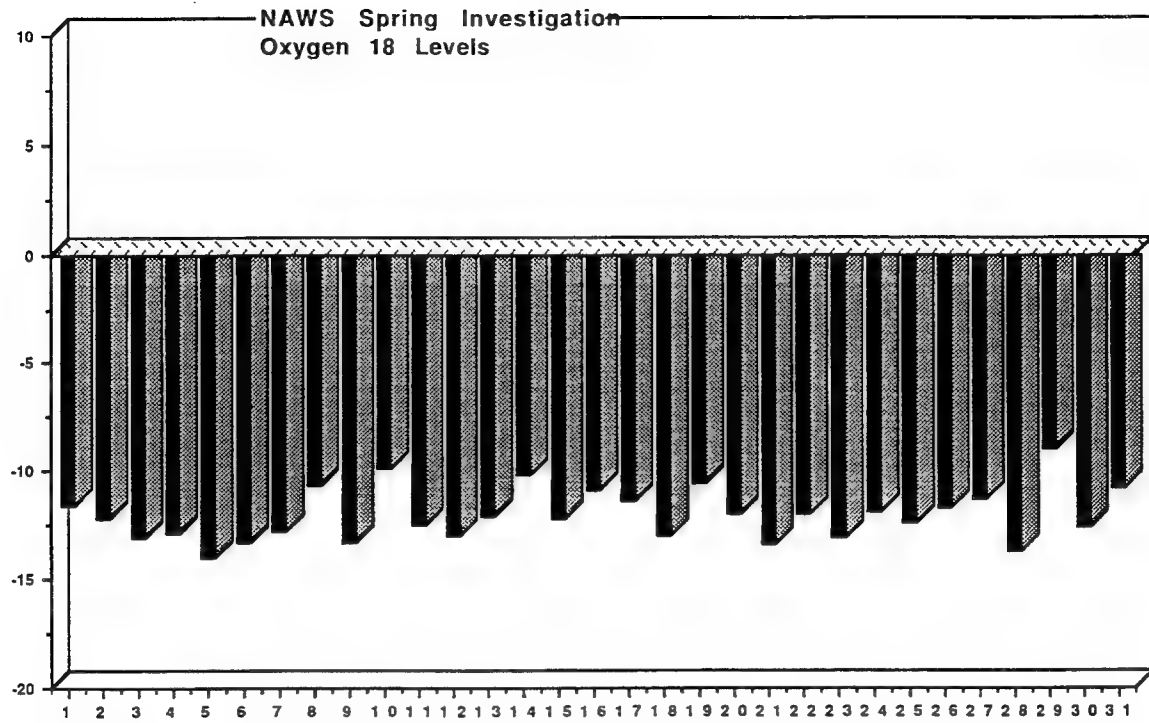




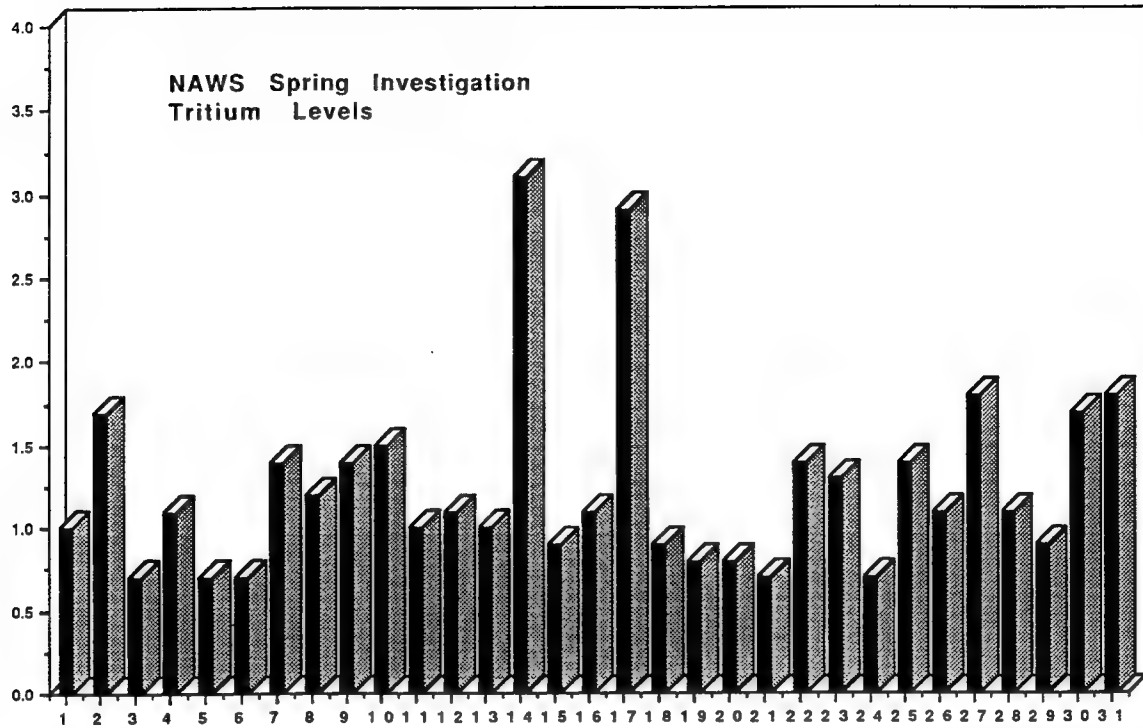












Appendix B  
SPRING RESISTIVITY SURVEYS



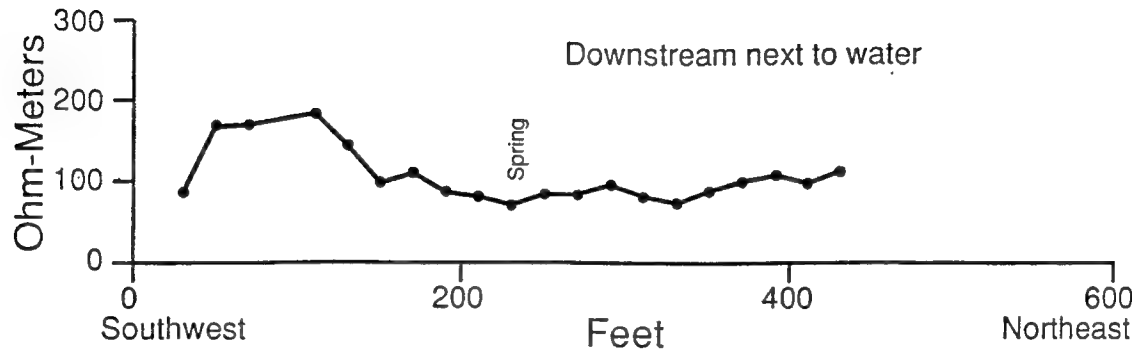
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0 300 600

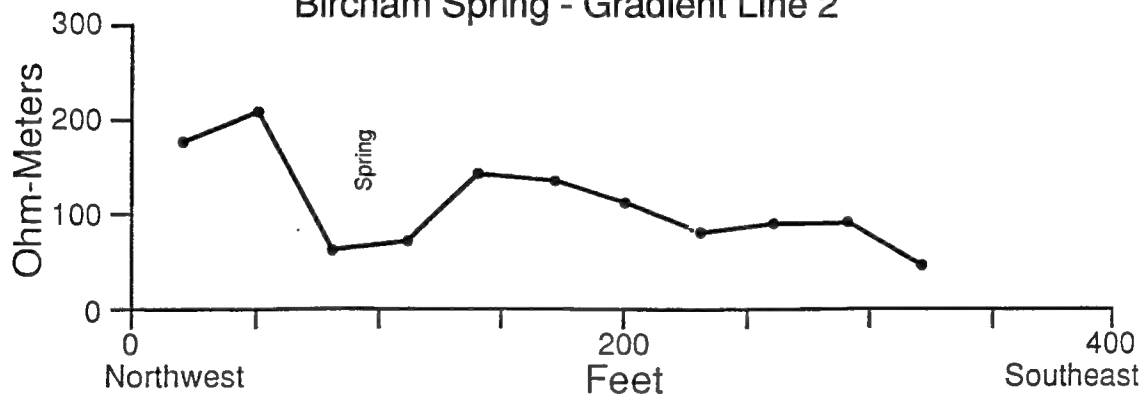


Bircham Spring — Electrical Resistivity Profiles.

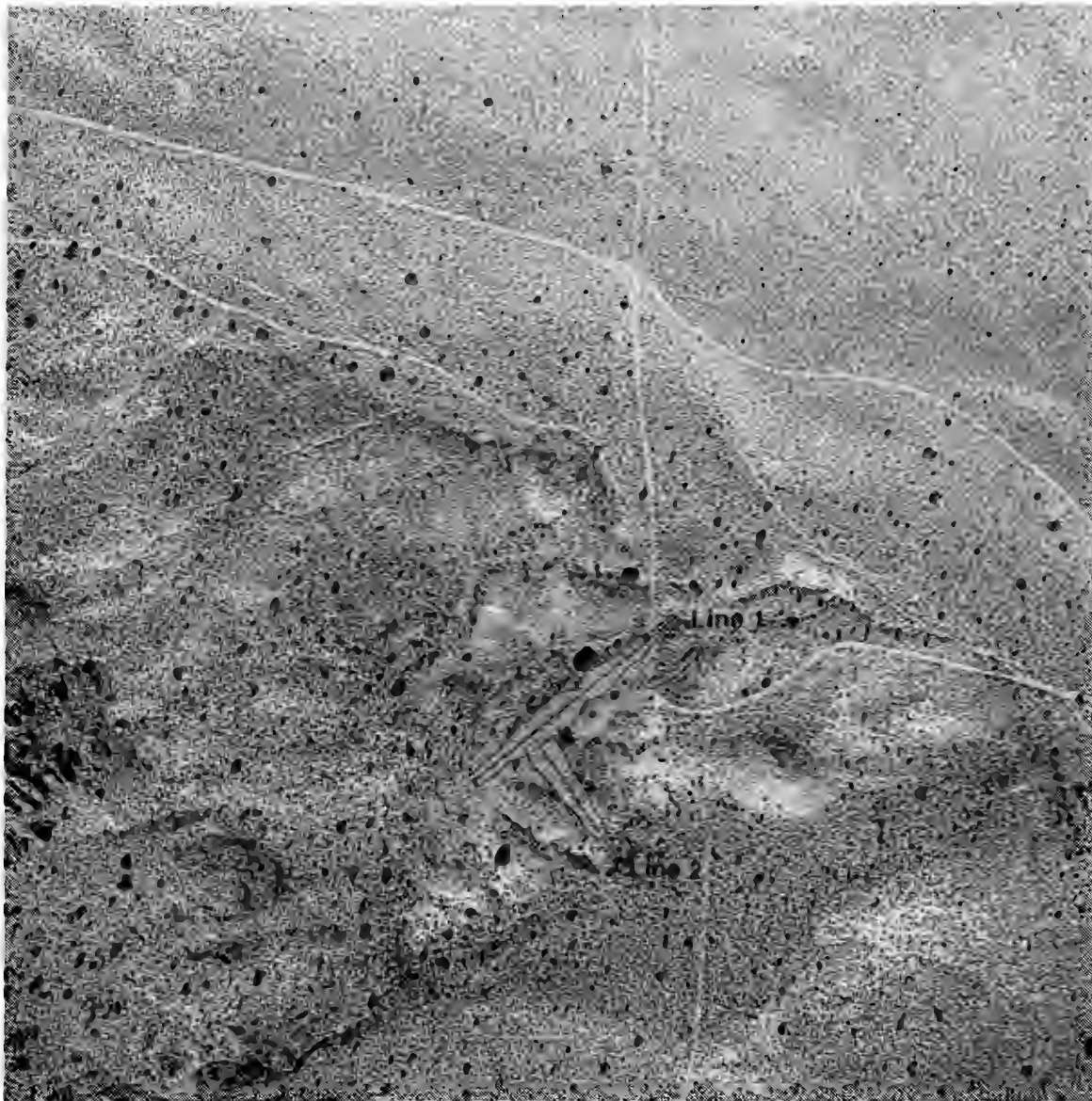
### Bircham Spring - Gradient Line 1



### Bircham Spring - Gradient Line 2



Bircham Spring — Electrical Resistivity Profiles.

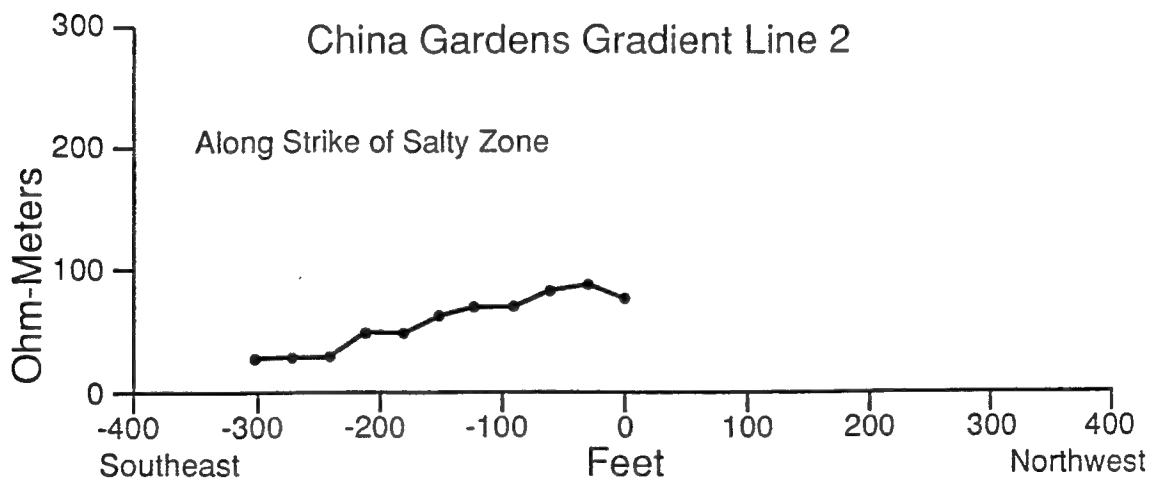
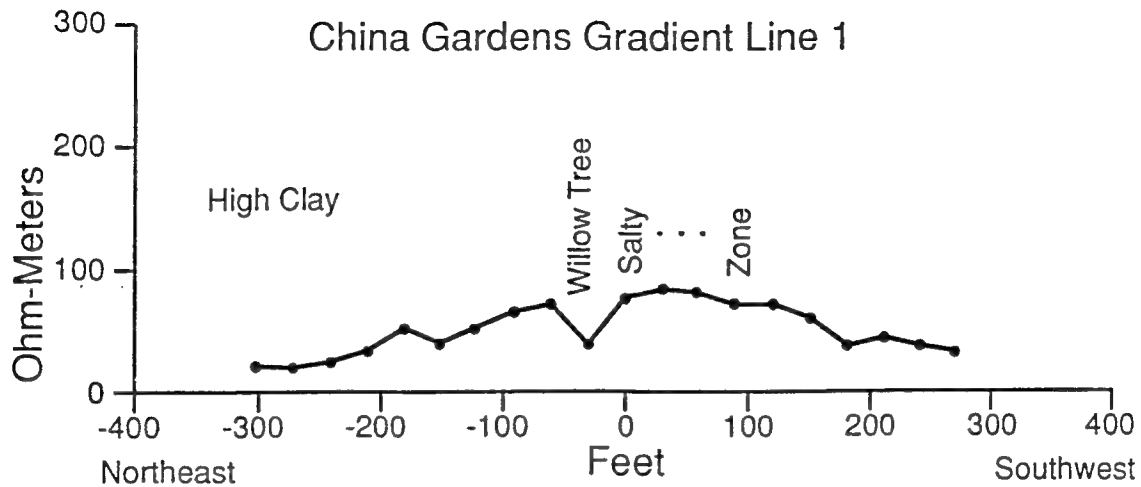


Scale 1" = 300'

0 300 600



China Garden Spring — Electrical Resistivity Profiles.



China Garden Spring — Electrical Resistivity Profiles.

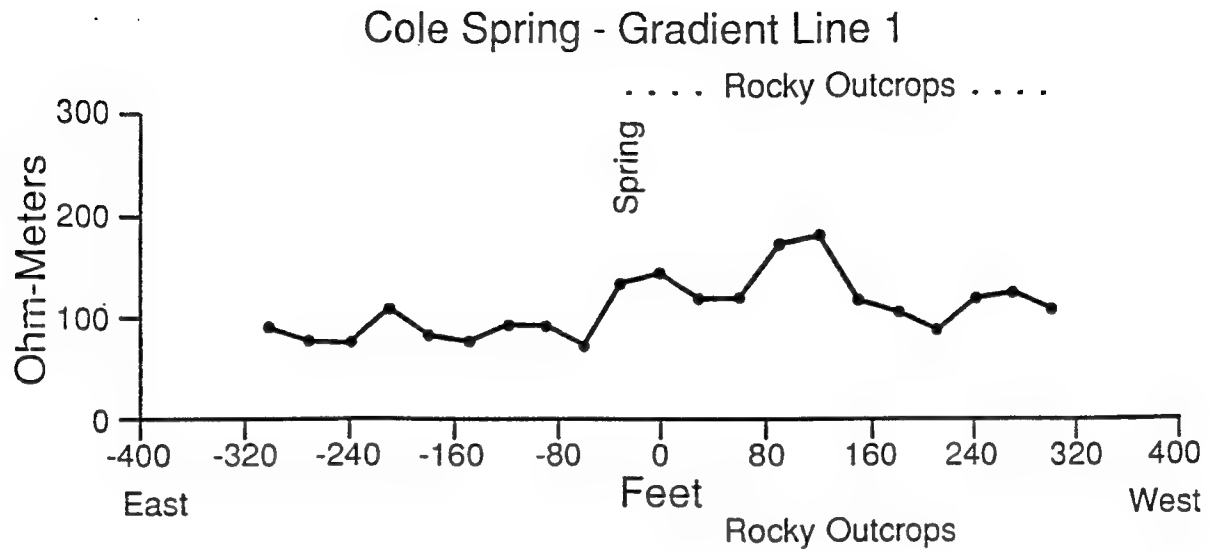


Scale 1" = 300'

0 300 600



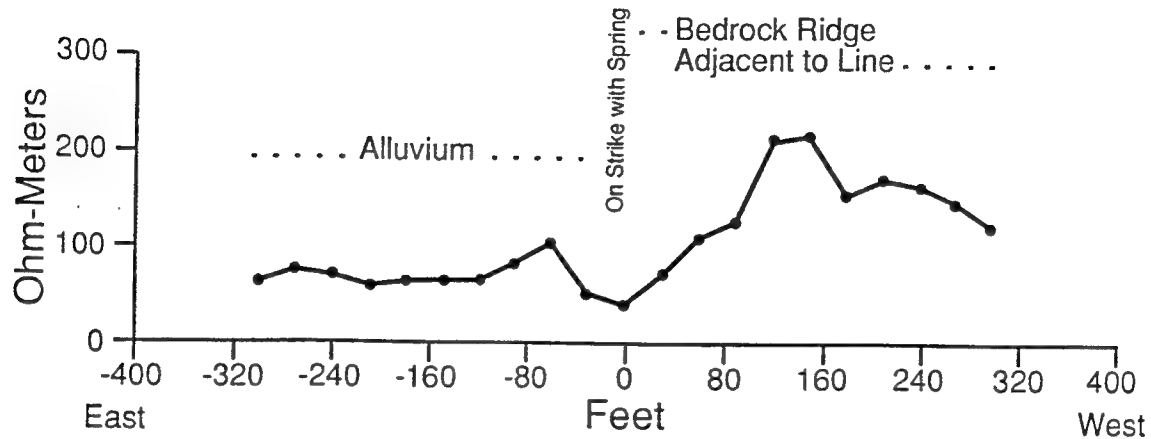
Cole Spring — Electrical Resistivity Profiles.



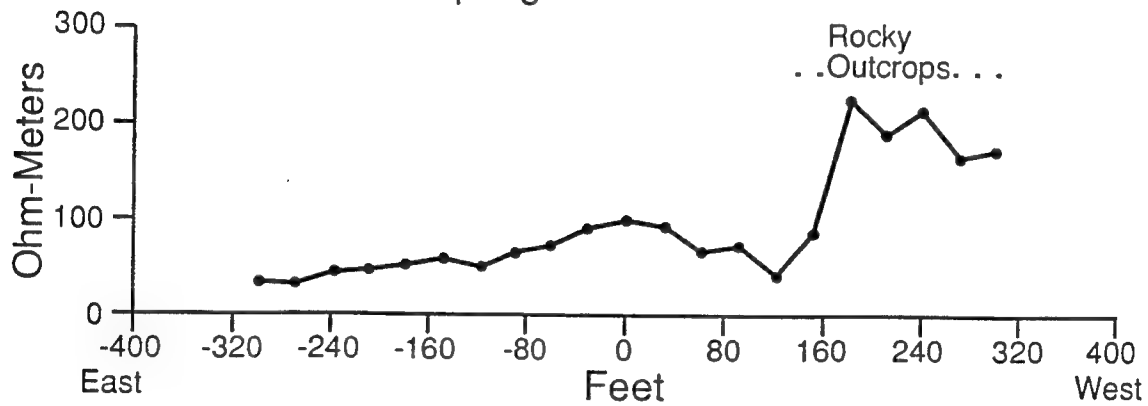
Cole Spring — Electrical Resistivity Profiles.



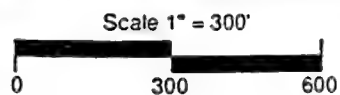
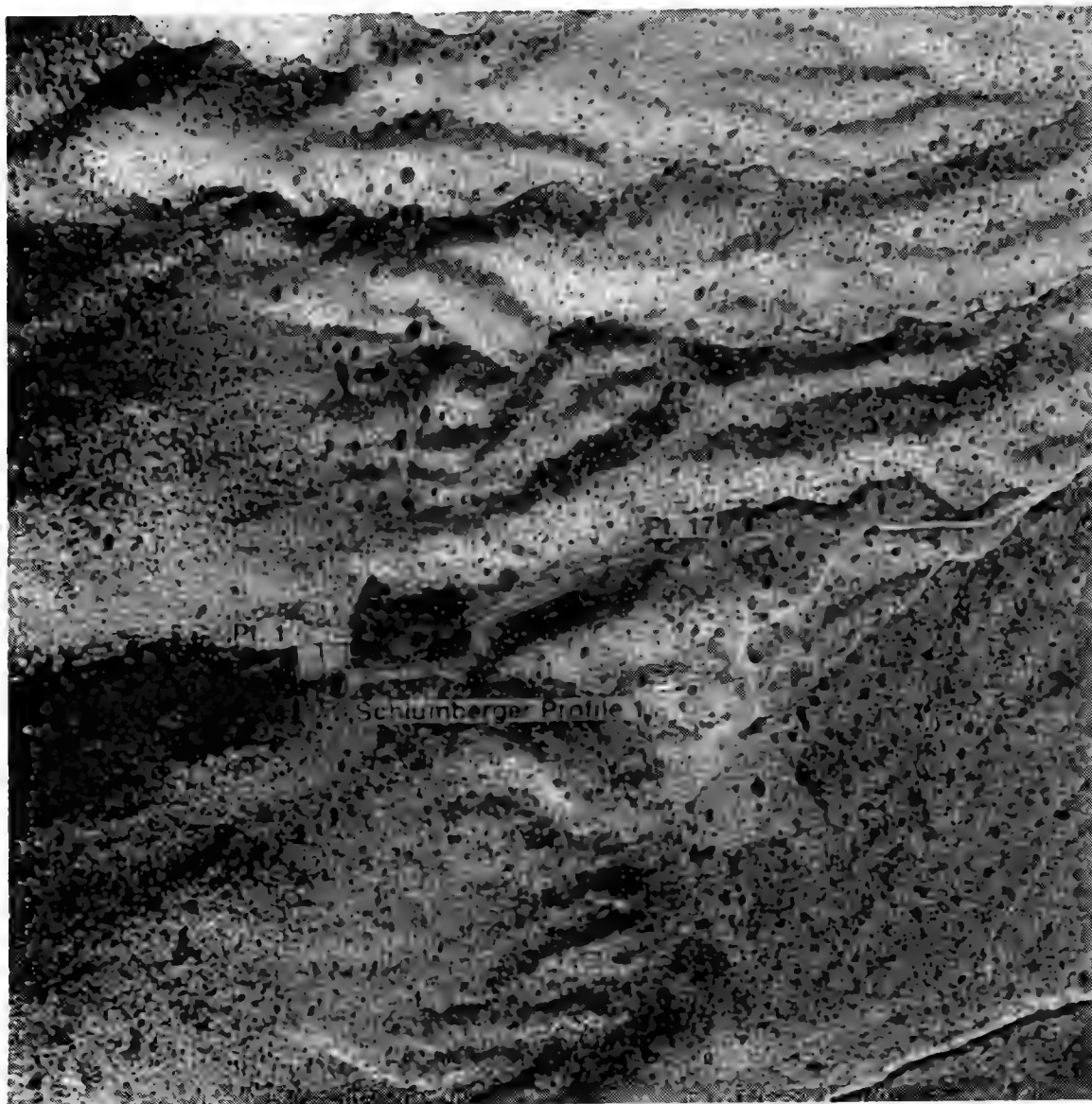
### Cole Spring - Gradient Line 10



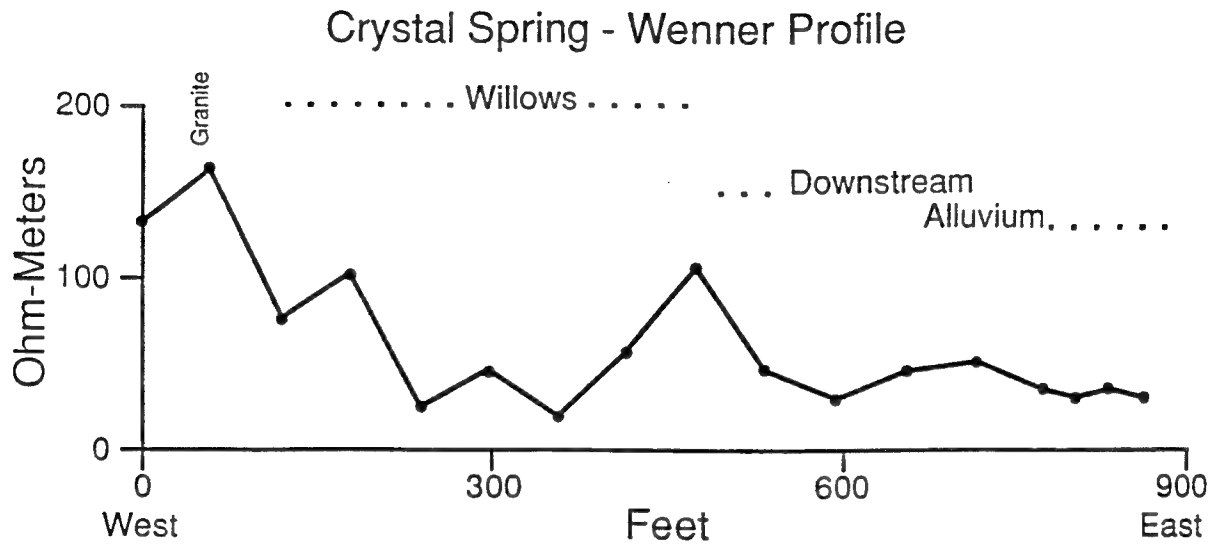
### Cole Spring - Gradient Line 11



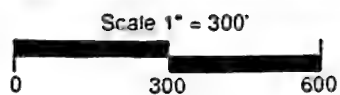
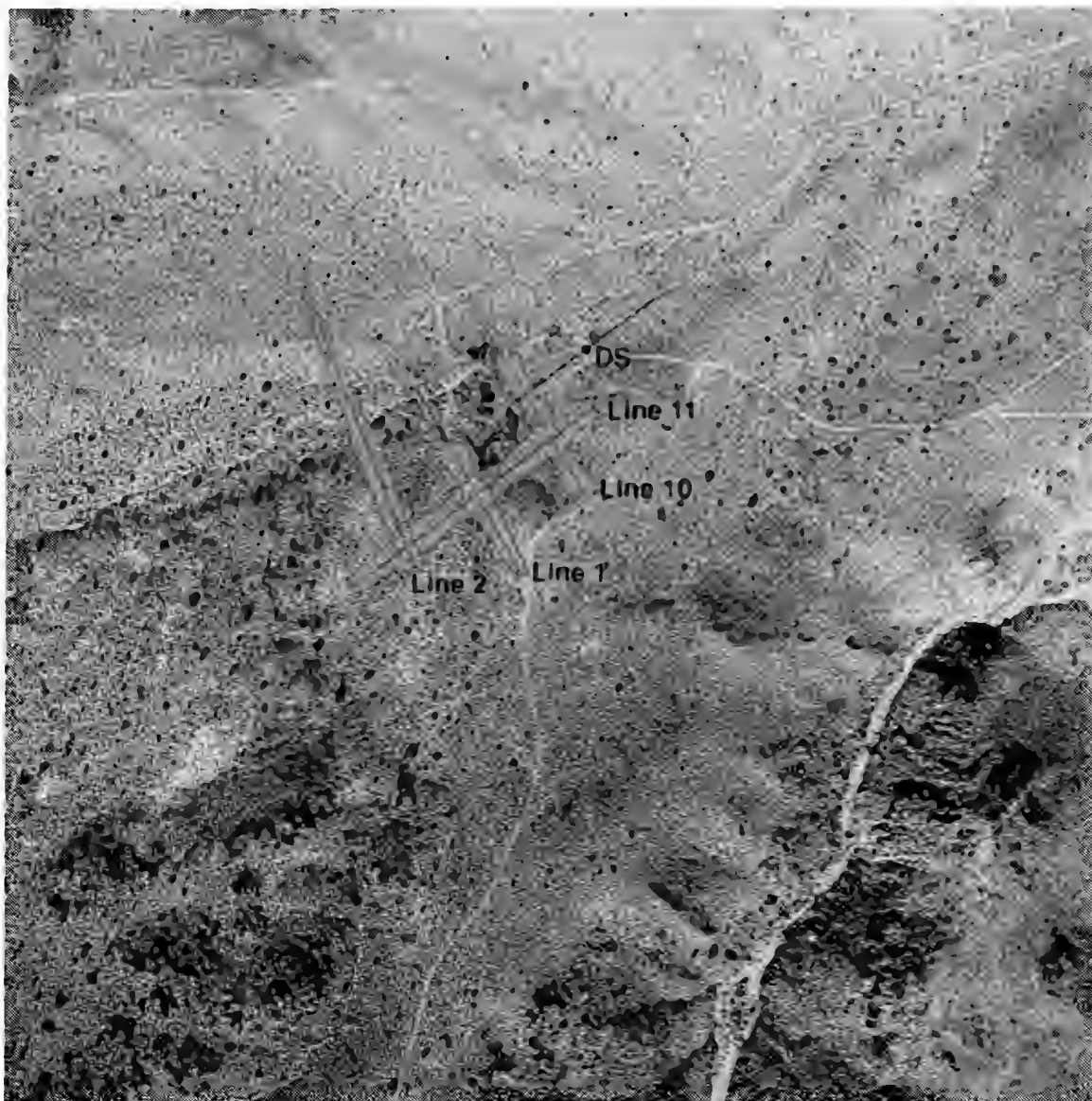
Cole Spring — Electrical Resistivity Profiles.



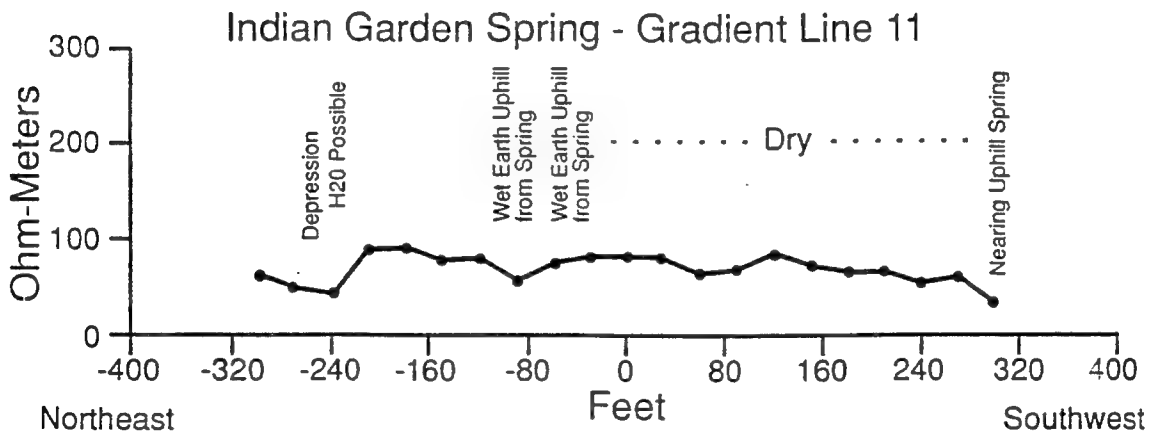
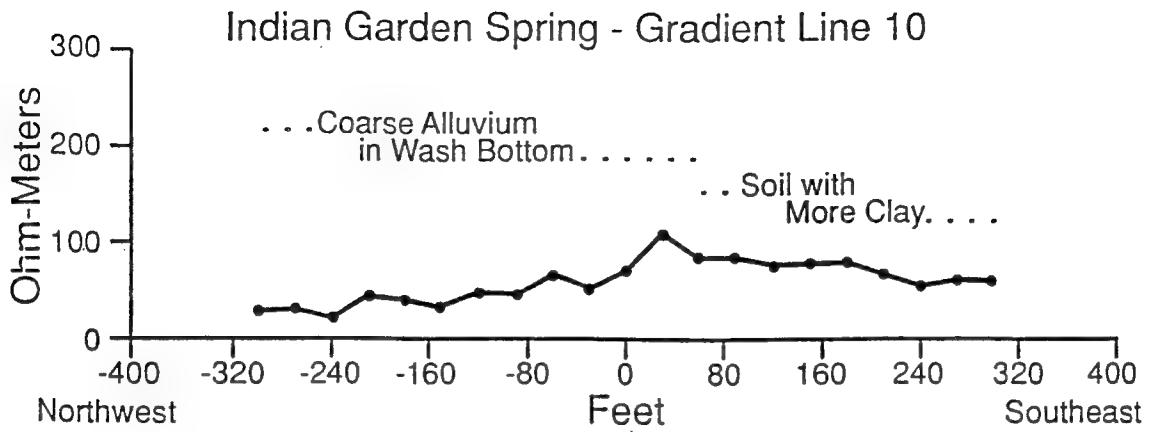
Crystal Spring — Electrical Resistivity Profiles.



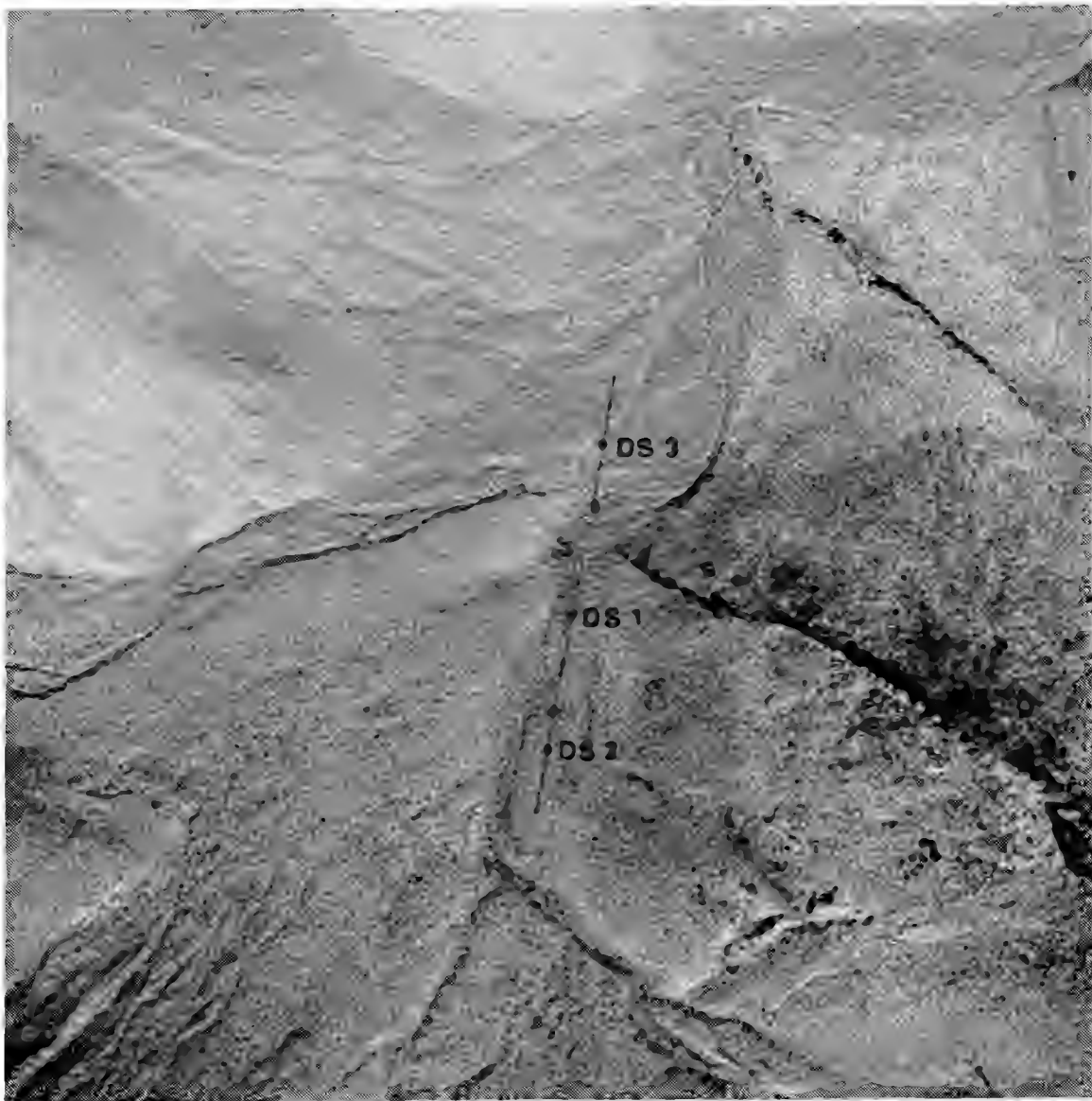
Crystal Spring — Electrical Resistivity Profiles.



Indian Garden Spring — Electrical Resistivity Profiles.



Indian Garden Spring — Electrical Resistivity Profiles.

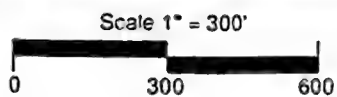


Scale 1" = 300'

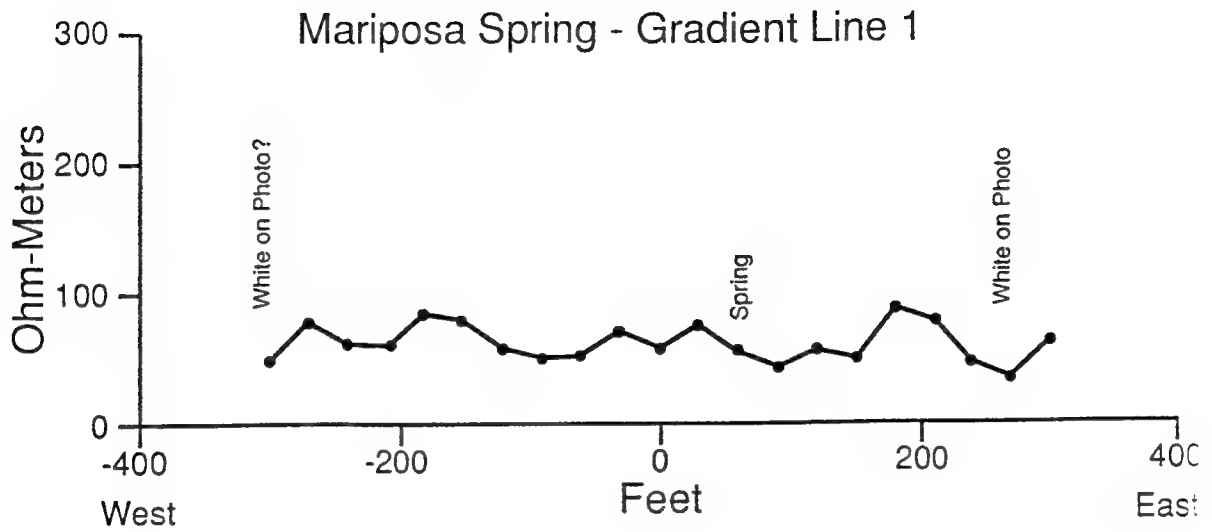
0 300 600



Lead Pipe Spring — Electrical Resistivity Profiles.

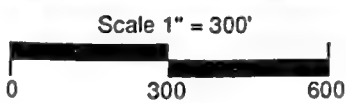


Mariposa Spring — Electrical Resistivity Profiles.

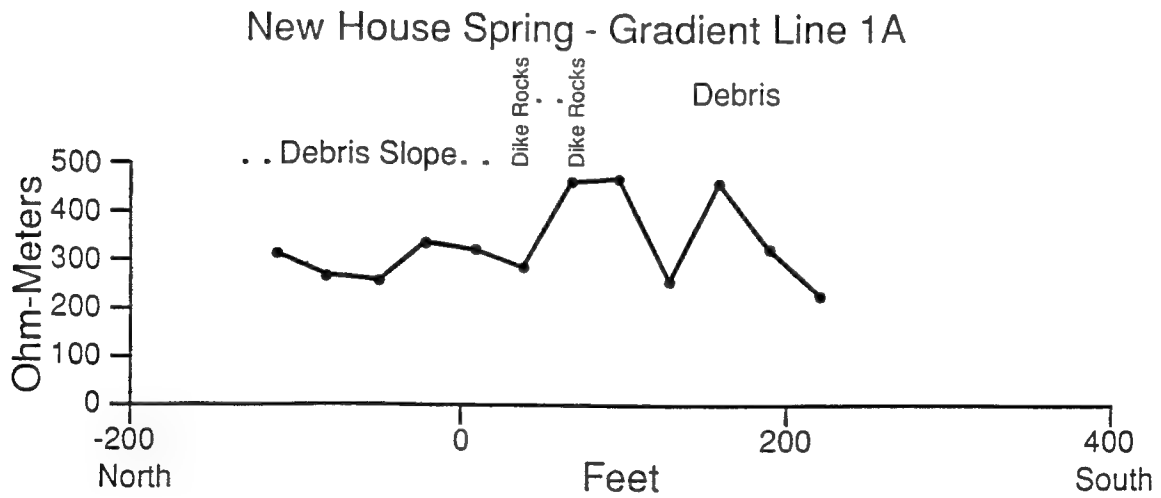
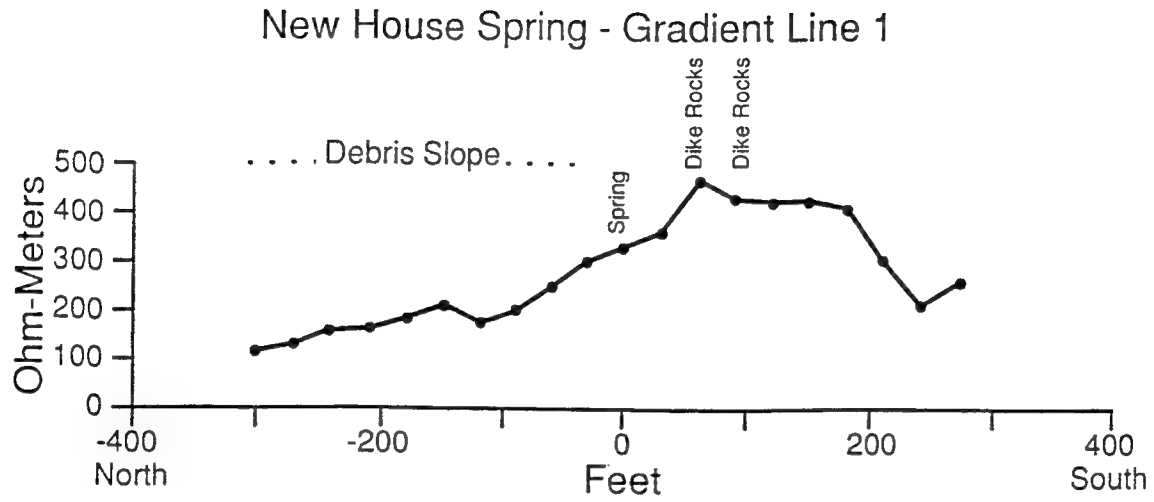


Mariposa Spring — Electrical Resistivity Profiles.

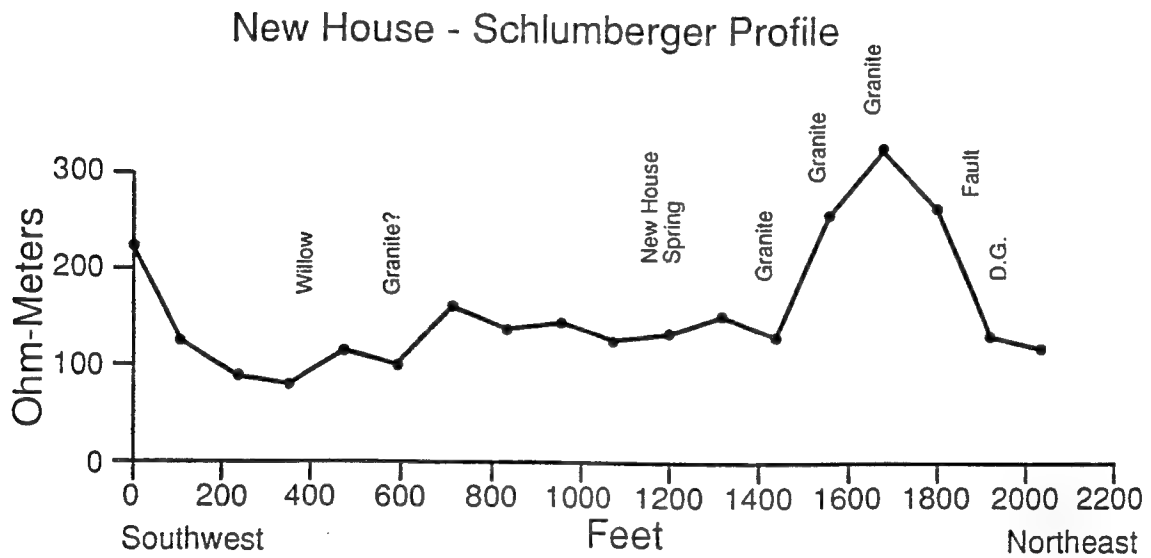
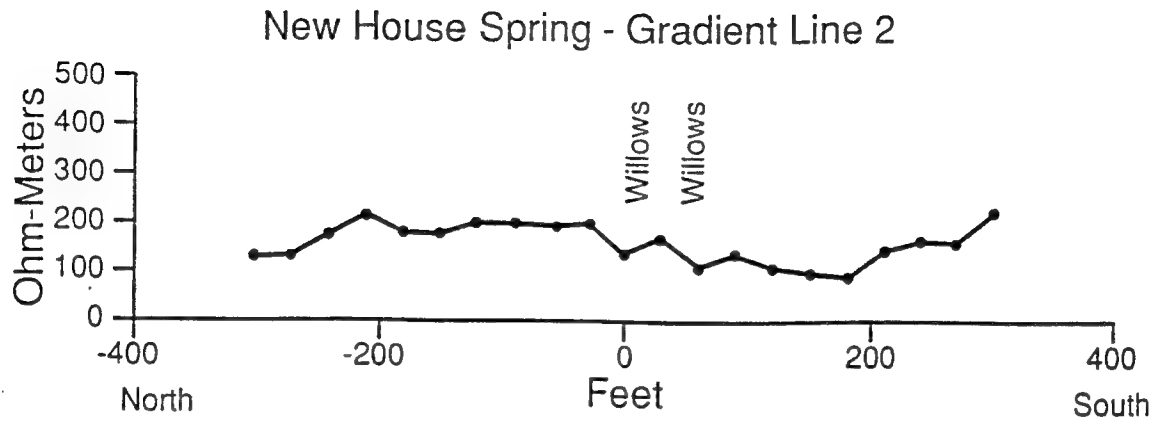




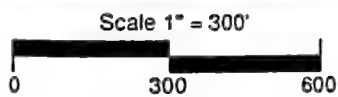
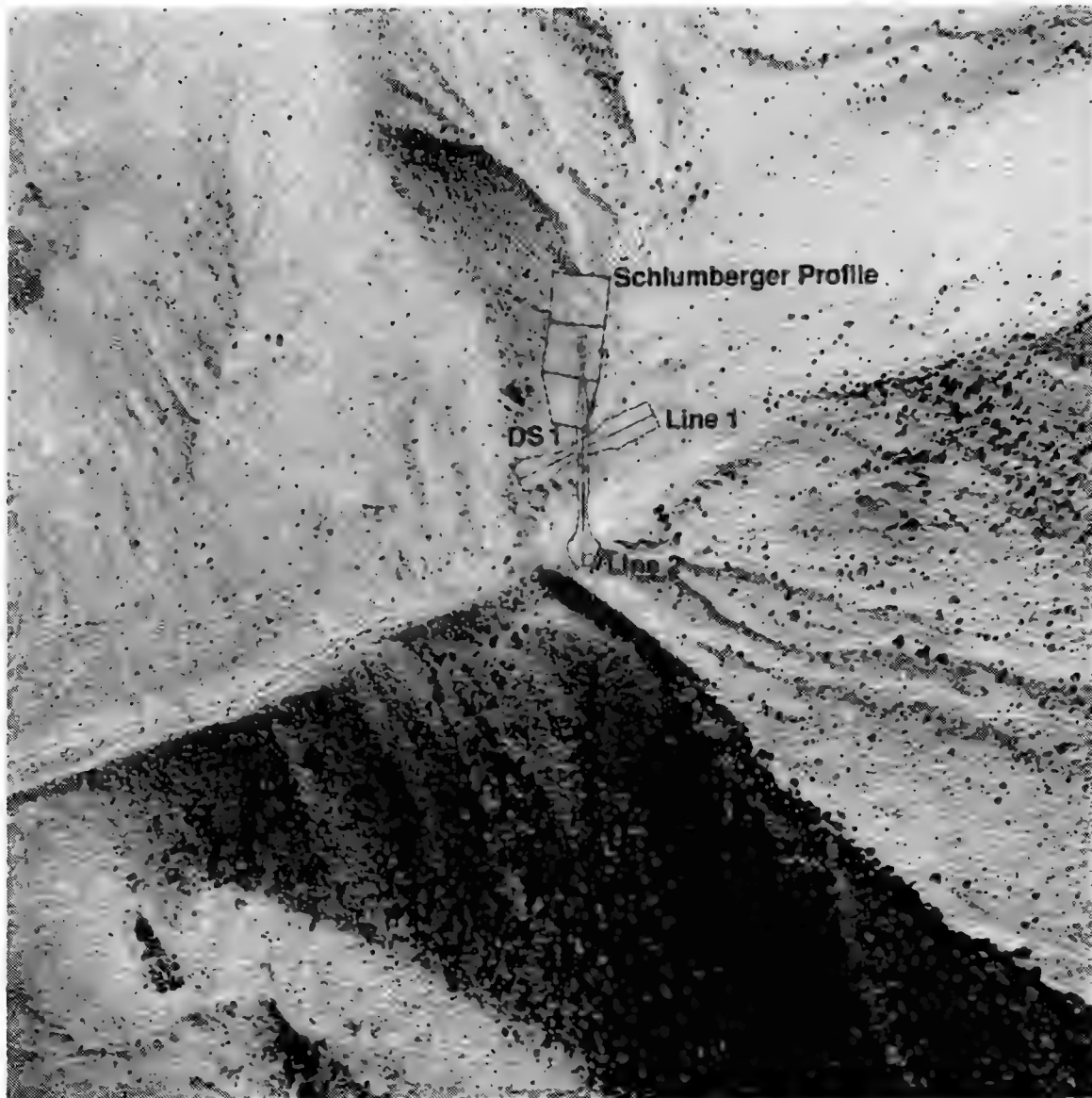
New House Spring — Electrical Resistivity Profiles.



New House Spring — Electrical Resistivity Profiles.

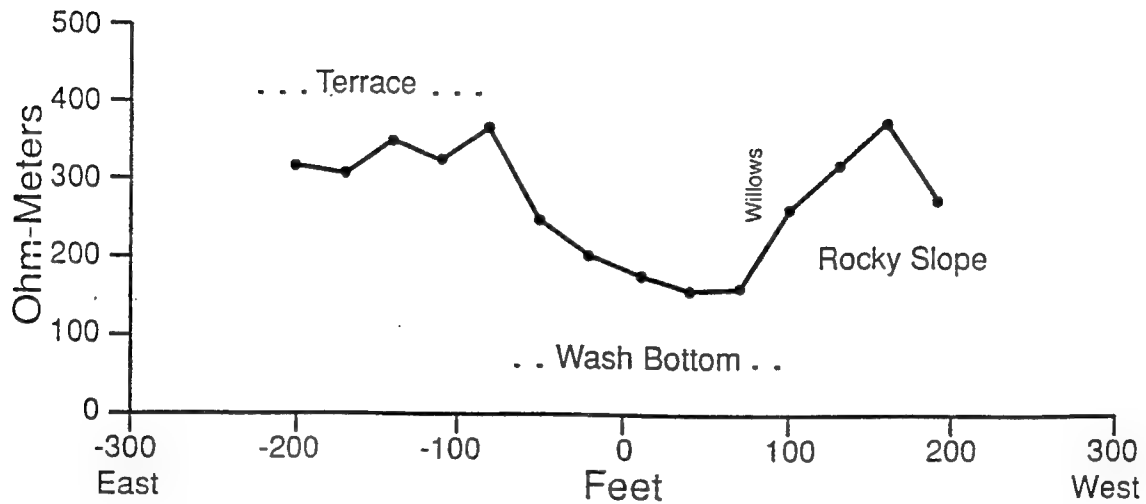


New House Spring — Electrical Resistivity Profiles.

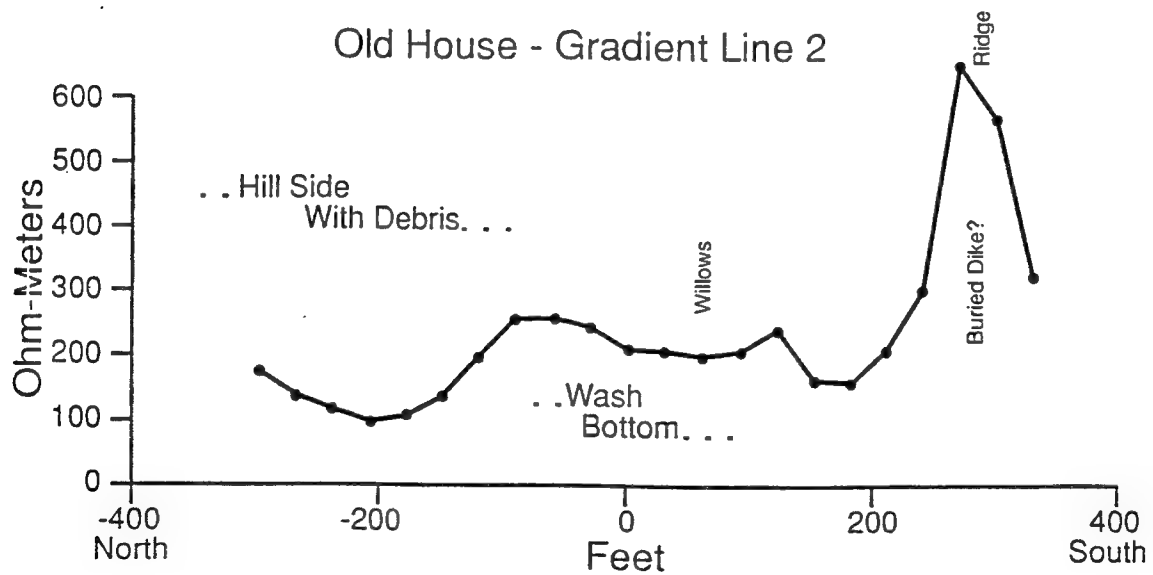


Old House Spring — Electrical Resistivity Profiles.

Old House - Gradient Line 1

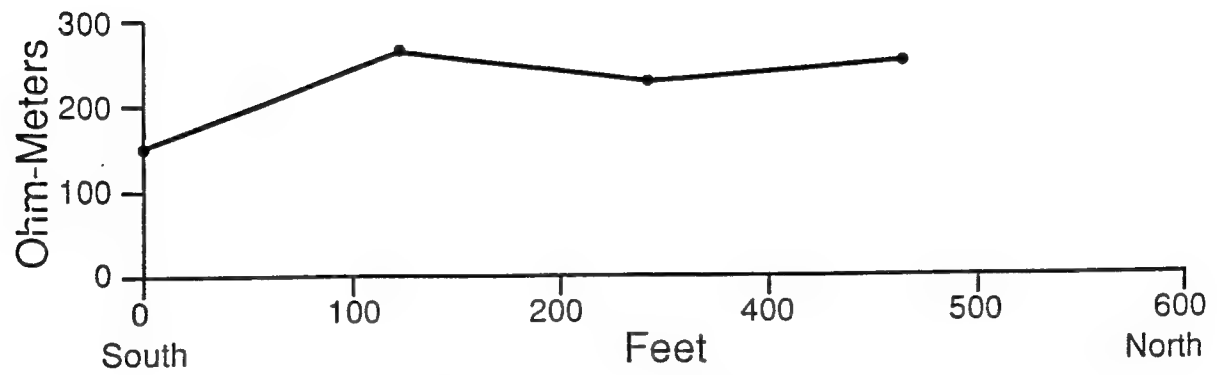


Old House - Gradient Line 2

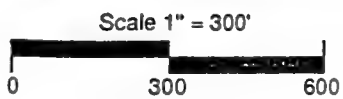


Old House Spring — Electrical Resistivity Profiles.

### Old House Spring - Schlumberger Profile

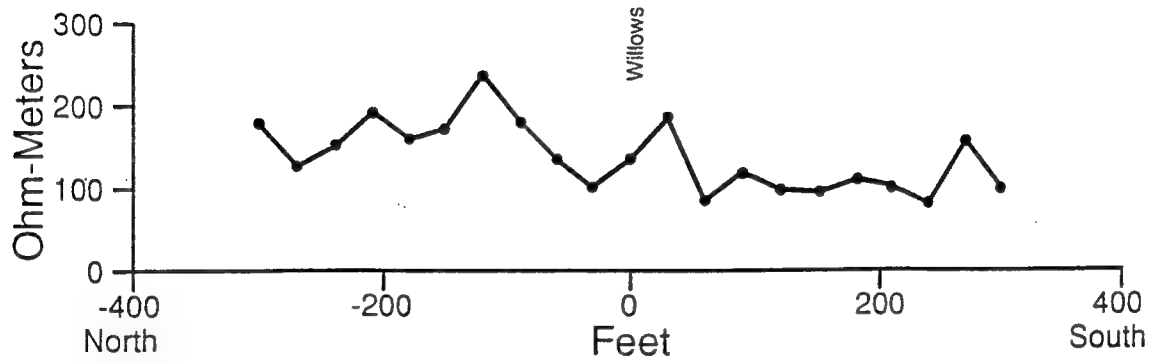


Old House Spring — Electrical Resistivity Profiles.

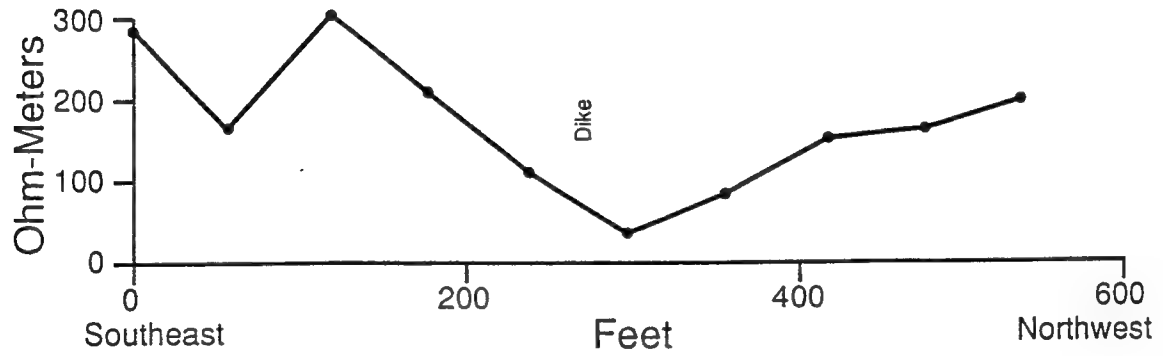


Tennessee Spring — Electrical Resistivity Profiles.

Tennessee Spring - Gradient Line 1



Tennessee Spring - Wenner Line 1

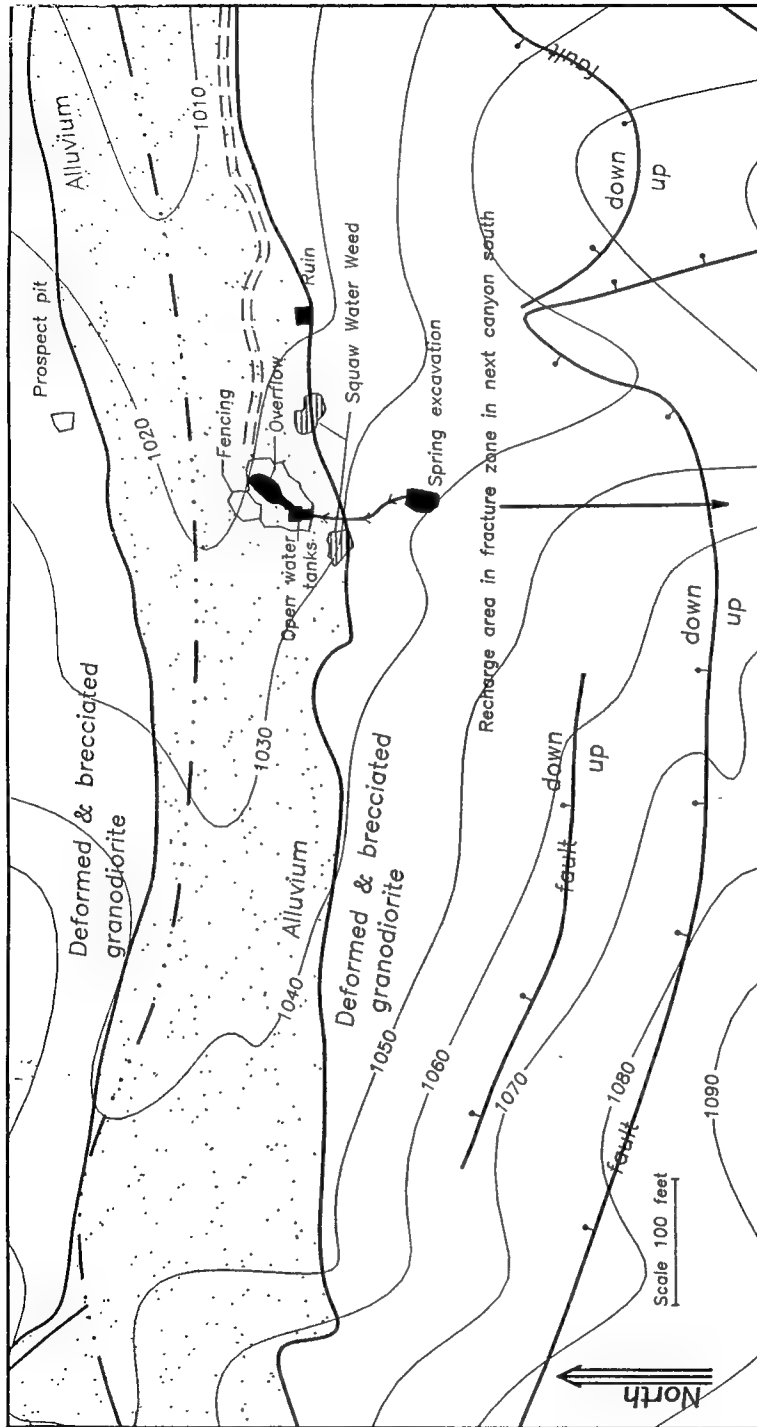


Tennessee Spring — Electrical Resistivity Profiles.



Appendix C  
GEOLOGIC MAPS

# AMITY



T. W. Bithorn, Earth Sciences Consultants

## Legend

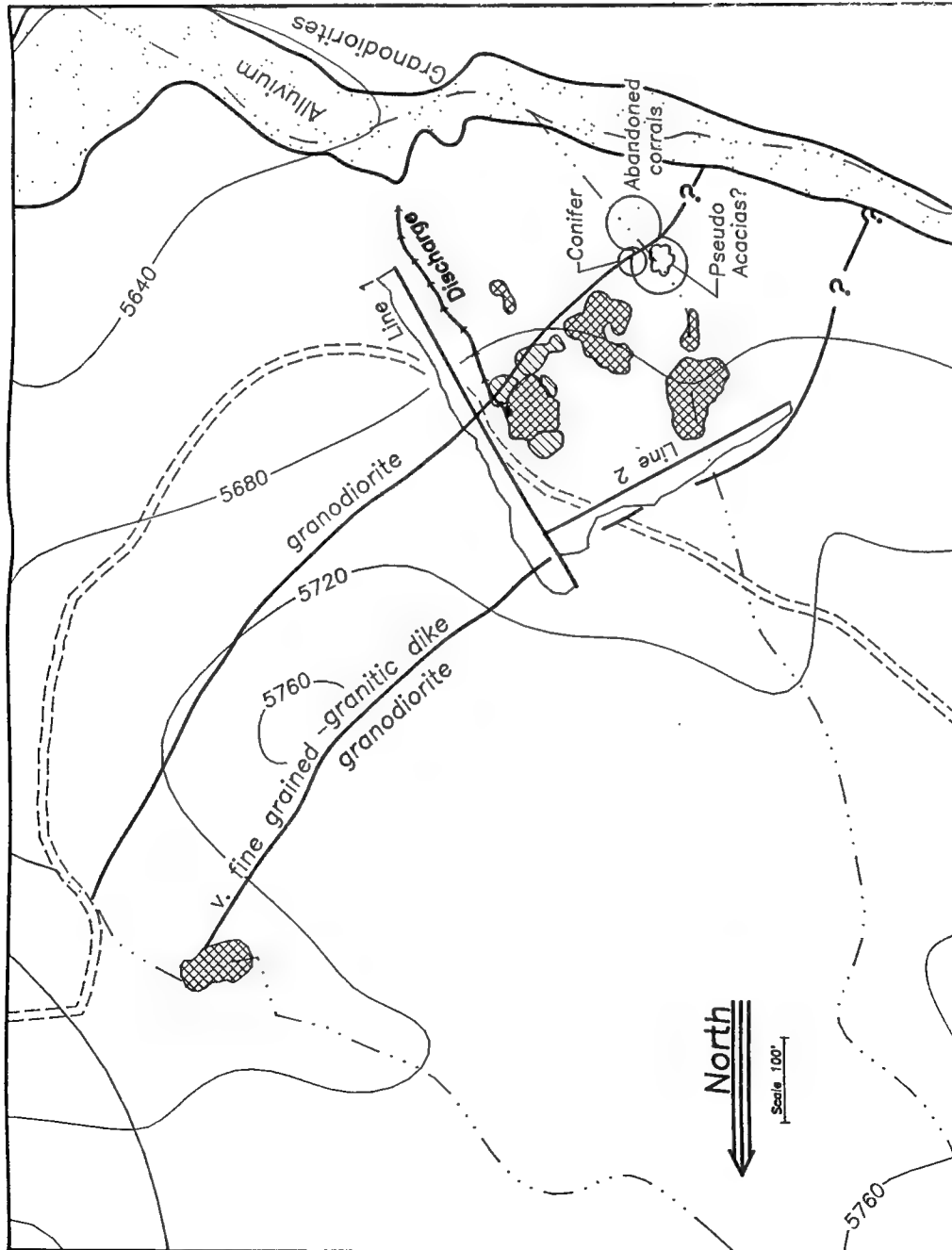
- 5540 — Ground contour
- == == == Dirt Road
- - - - - granodiorite
- ..... alluvium
- - - - - Intermittent stream
- - - - - Fault plane dipping toward symbols

- Flowing surface water or pipe
- Resistivity profile showing curve of resistivity
- Squaw Water Weed (Baccharis sergioides)
- Alluvium

## Notes

- Contour Interval is 10 meters
- Scale 1" = 100'
- File: Amity-7 3/15/94

# BIRCHAM



## Legend

- 5640 — Ground contour
- Dirt road
- granodiorite Alluvium
- Intermittent stream
- Fault plane, dipping toward symbol
- Flowing surface water or pipe
- Resistivity profile showing curve of resistivity

- Arroyo willow
- Mesquite
- Alluvium

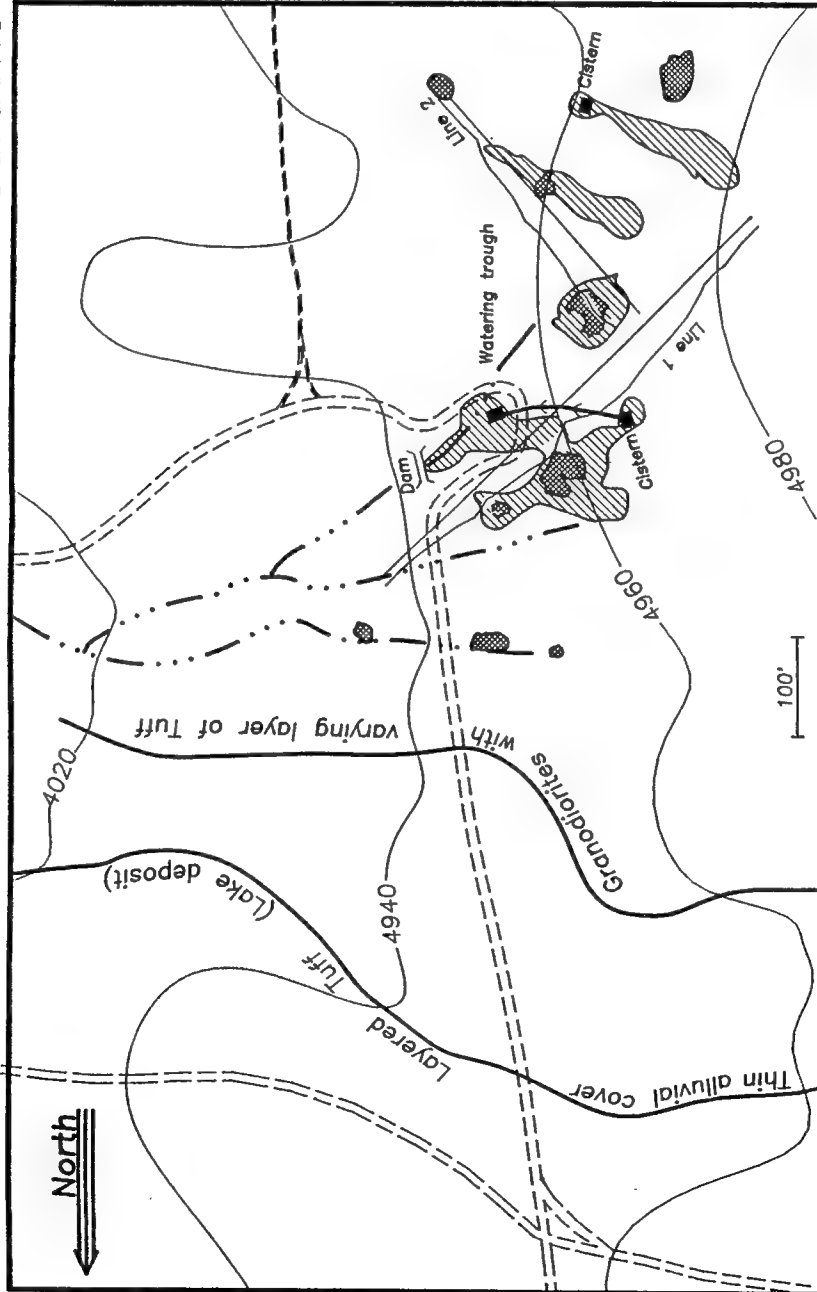
## Notes

Contour Interval is 40 feet  
Scale 1" = 150'

File: Birchum-7 3/15/94

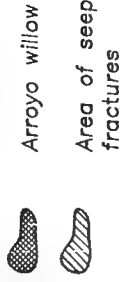
T. W. Bilhorn, Earth Sciences Consultants

# China Gardens



## Legend

- 5640 — Ground contour
- - - - - Dirt road
- granodiorite / Alluvium — Geologic contact
- . . . - Intermittent stream
- • • • - Fault plane, dipping toward symbol
- ○ ○ ○ - Flowing surface water or pipe
- | | | - Resistivity profile showing curve of resistivity



## Notes

Contour Interval is 20 feet

Scale 1" = 150'

File: China Gardens 6 3/15/94

T. W. Bilhorn, Earth Sciences Consultants

Cole



### Legend

- 5640 — Ground contour
- - - - - Dirt Road
- granodiorite — Geologic Contact
- alluvium — Intermittent stream

- Fault plane dipping toward symbols
- Flowing surface water or pipe
- Resistivity profile showing curve of resistivity

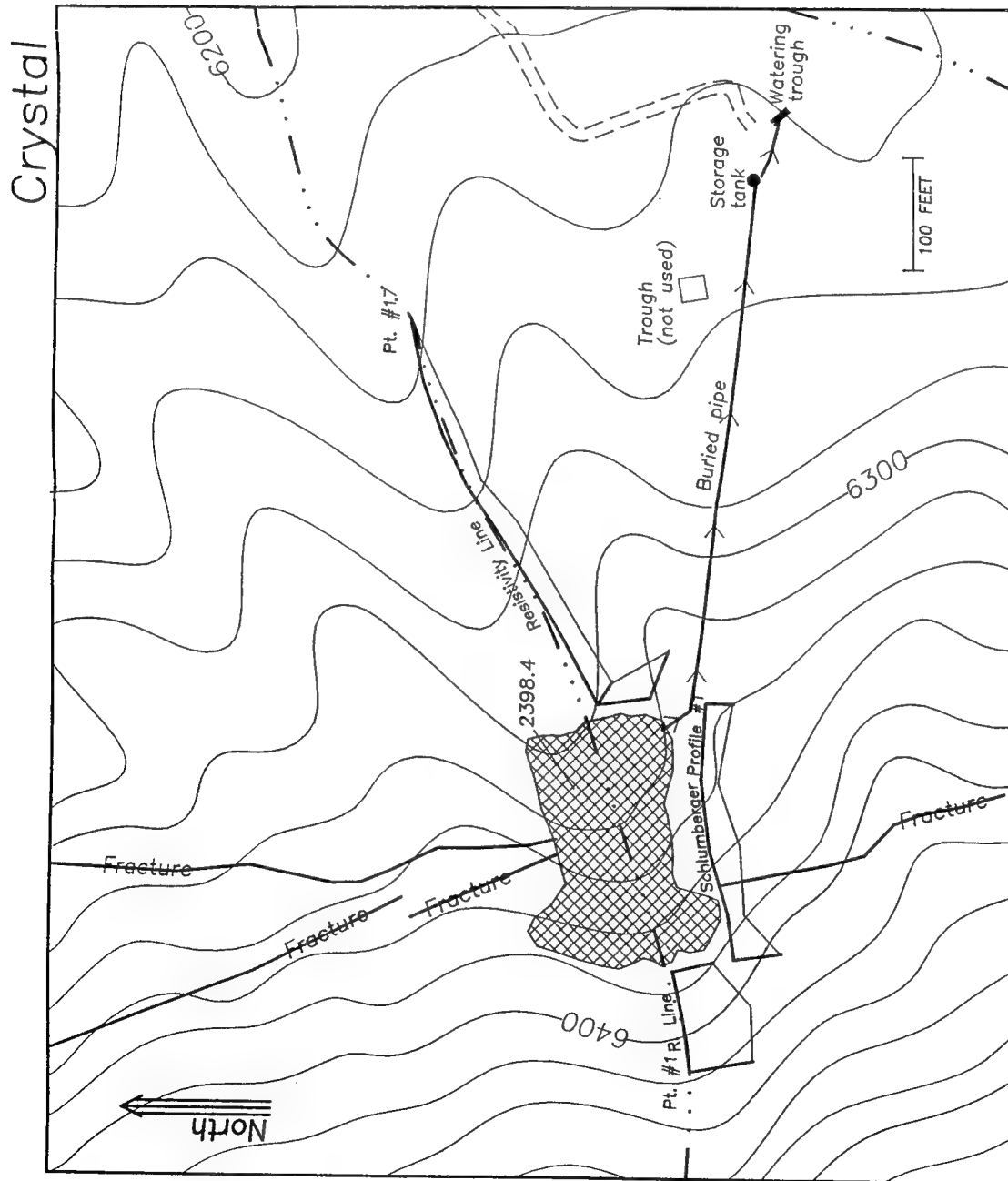
- Alluvium
- Dike, conduit—fracture
- Intermixed weathered granitic rocks and tuffs

T. W. Blihorn, Earth Sciences Consultants

File: Cole-9 3/15/94

### Notes

No riparian vegetation at the site  
(See Text)  
Contour Interval is 20 feet  
Scale 1" = 150'



Legend	
	Ground contour
	Dirt Road
	granodiorite alluvium
	Geologic Contact
	Intermittent stream
	Fault plane dipping toward symbols
	Flowing surface water or pipe
	Resistivity profile showing curve of resistivity
	Arroyo willow

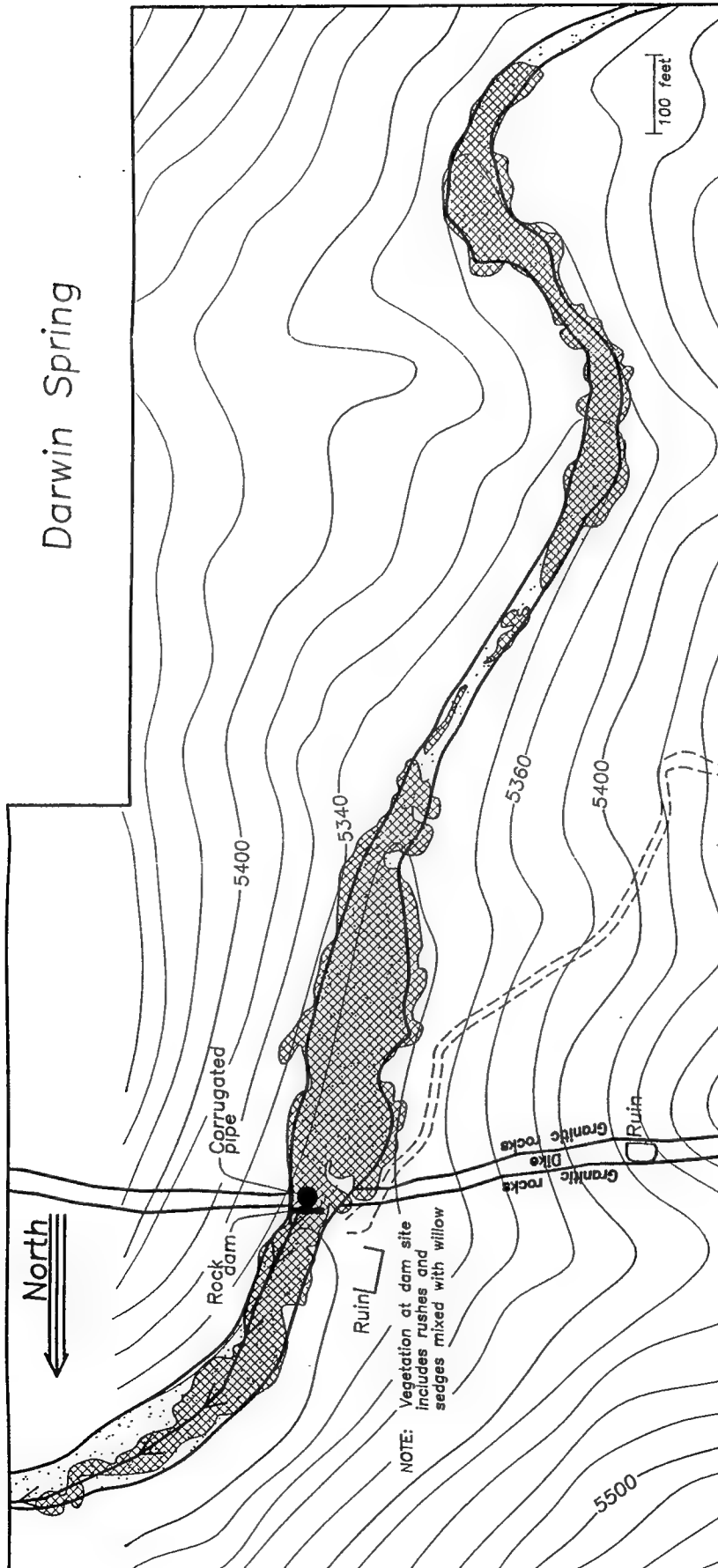
**Notes**

Contour Interval is 20 feet

Scale 1" = 150'

File: Crystal-6 3/16/94

T. W. Bilhorn, Earth Sciences Consultants



T. W. Bihorn, Earth Sciences Consultants

## Notes

Contour Interval is 20 feet

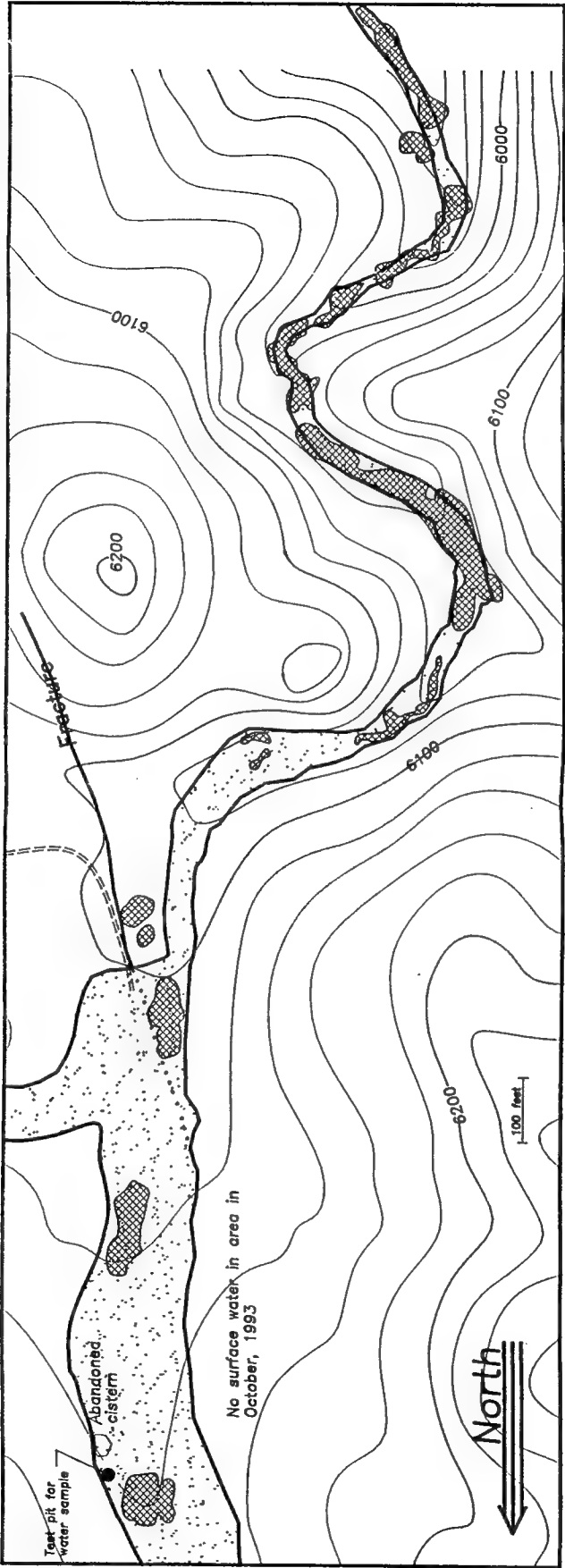
Scale 1" = 150'

File: Darwin-5 2/20/94

## Legend

- 5640— Ground contour
- - - - - Dirt road
- granodiorite Alluvium
- Geologic contact
- Flowing surface water or pipe
- Arroyo willow
- Alluvium

DEAD END CABIN



T. V. Biliom, Earth Sciences Consultants

File: Dabn-82 1/19/94

Notes

Contour Interval is 20 feet

Scale 1" = 200'

Vegetation identification tentative as full area not examined in field

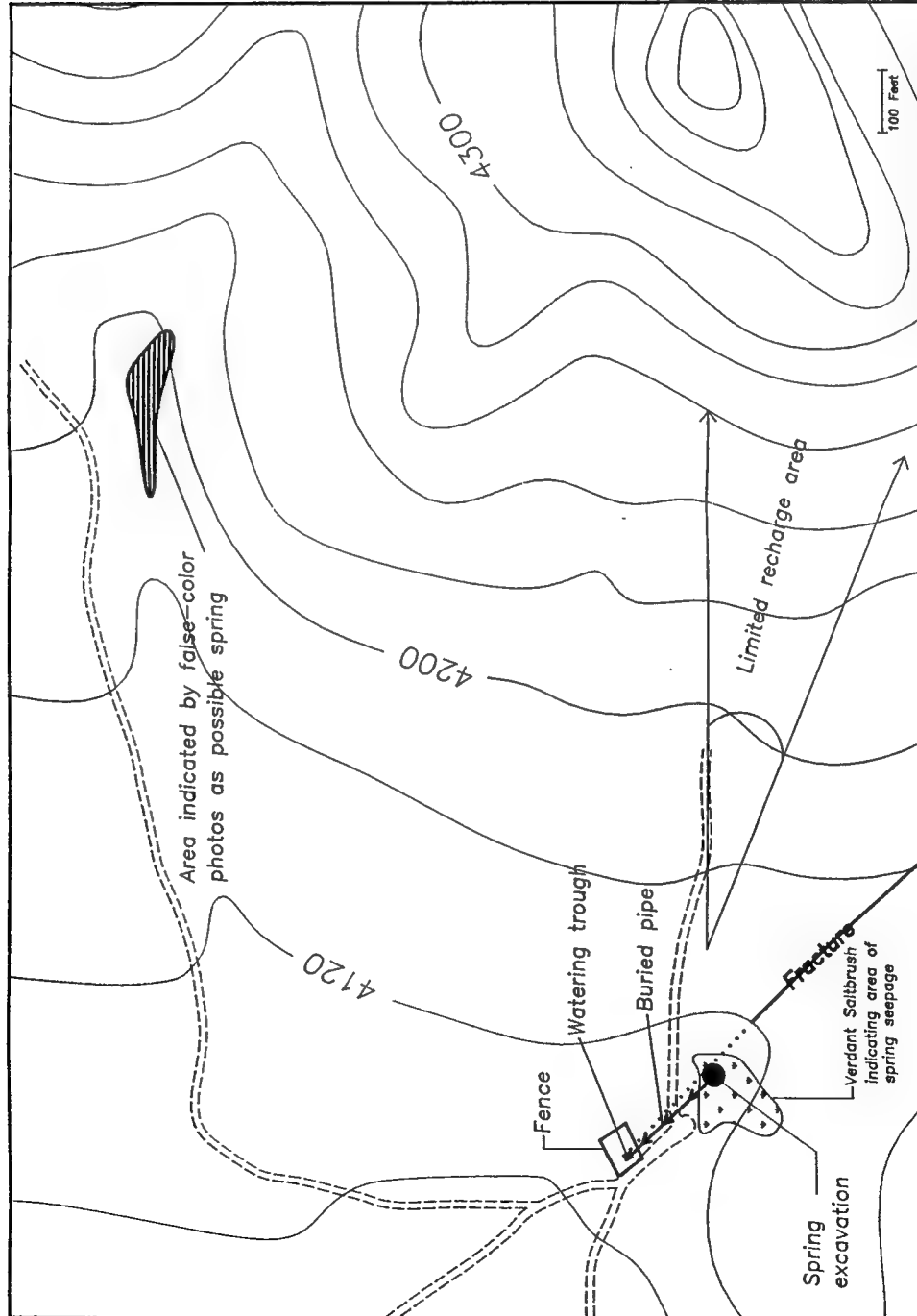
Photo/topographic match in south half of area is poor.

Legend

- 5540 — Ground contour
- == Dirt road
- granodiorite Alluvium
- Geologic contact
- Flowing surface water or pipe
- Arroyo willow
- Alluvium



# Granite Wells



## Legend

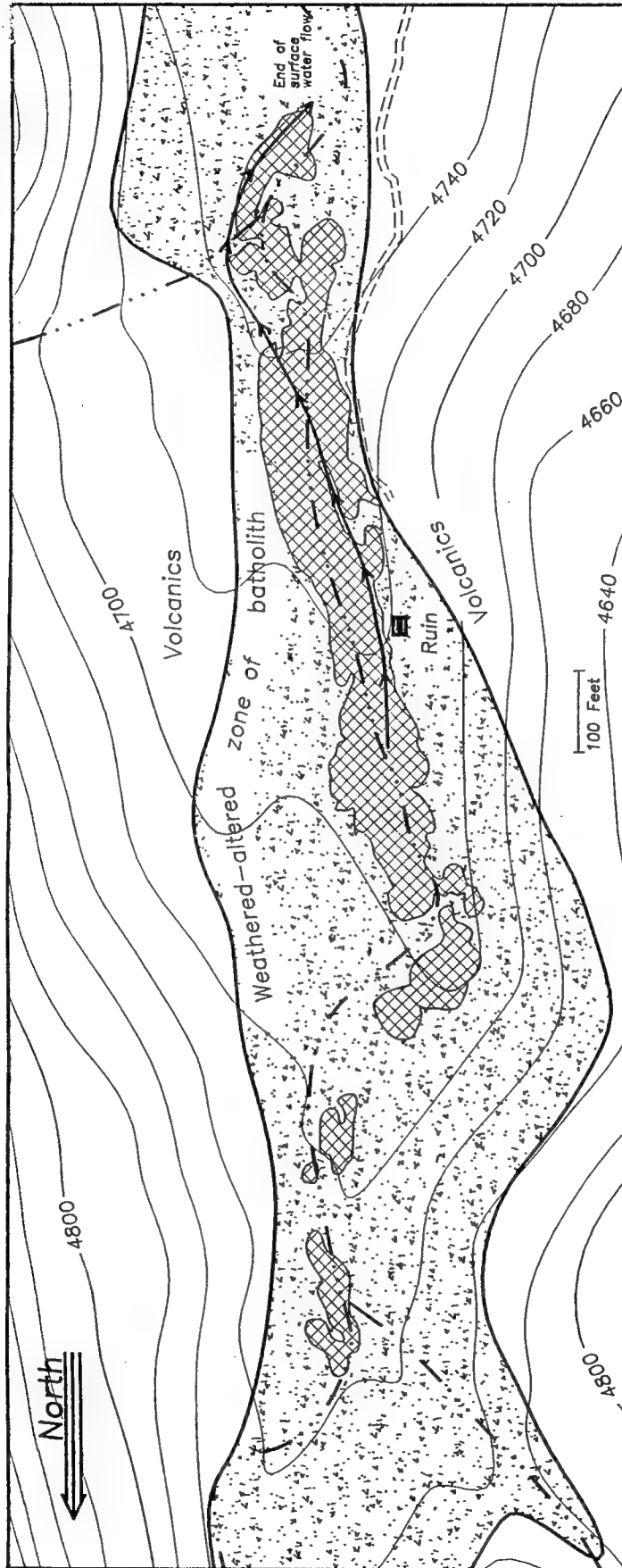
- 5640 — Ground contour
- - - - - Dirt Road
- granodiorite alluvium — Geologic Contact
- . . . - . . . - Intermittent stream
- - - - - Fault plane dipping toward symbols
- → → → → Flowing surface water or pipe
- — — — — Resistivity profile showing curve of resistivity
- Saltbrush

## Notes

- Contour Interval is 40 feet
- Scale 1" = 200'
- File: Granit-2 3/16/94

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# HAWIEE



## Legend

- 5640 — Ground contour
- Dirt road
- granodiorite
- Aluvium
- Geologic contact

- Flowing surface water or pipe
- Arroyo willow
- Weathered-altered zone

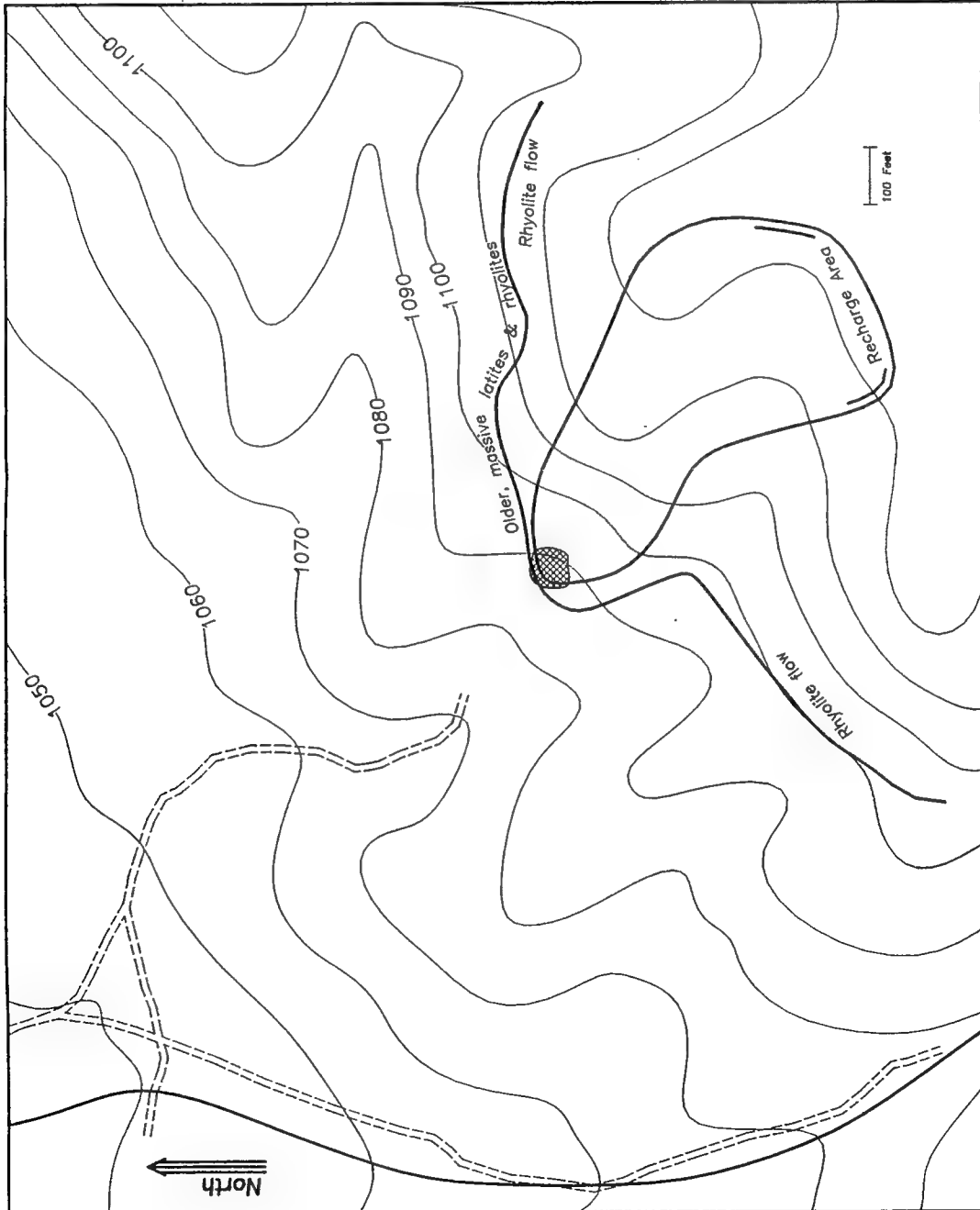
## Notes

- Contour Interval is 20 feet
- Scale 1" = 150'

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File: Hawiee-3 1/20/94

# Hidden



## Legend

- 5640 — Ground contour
- - - - - Dirt road
- granodiorite — Alluvium — Geologic contact
- . . . - Intermittent stream
- . - . - Fault plane, dipping toward symbol
- - - - - Flowing surface water or pipe
- - - - - Resistivity profile showing curve of resistivity
- ▨ Arroyo willow

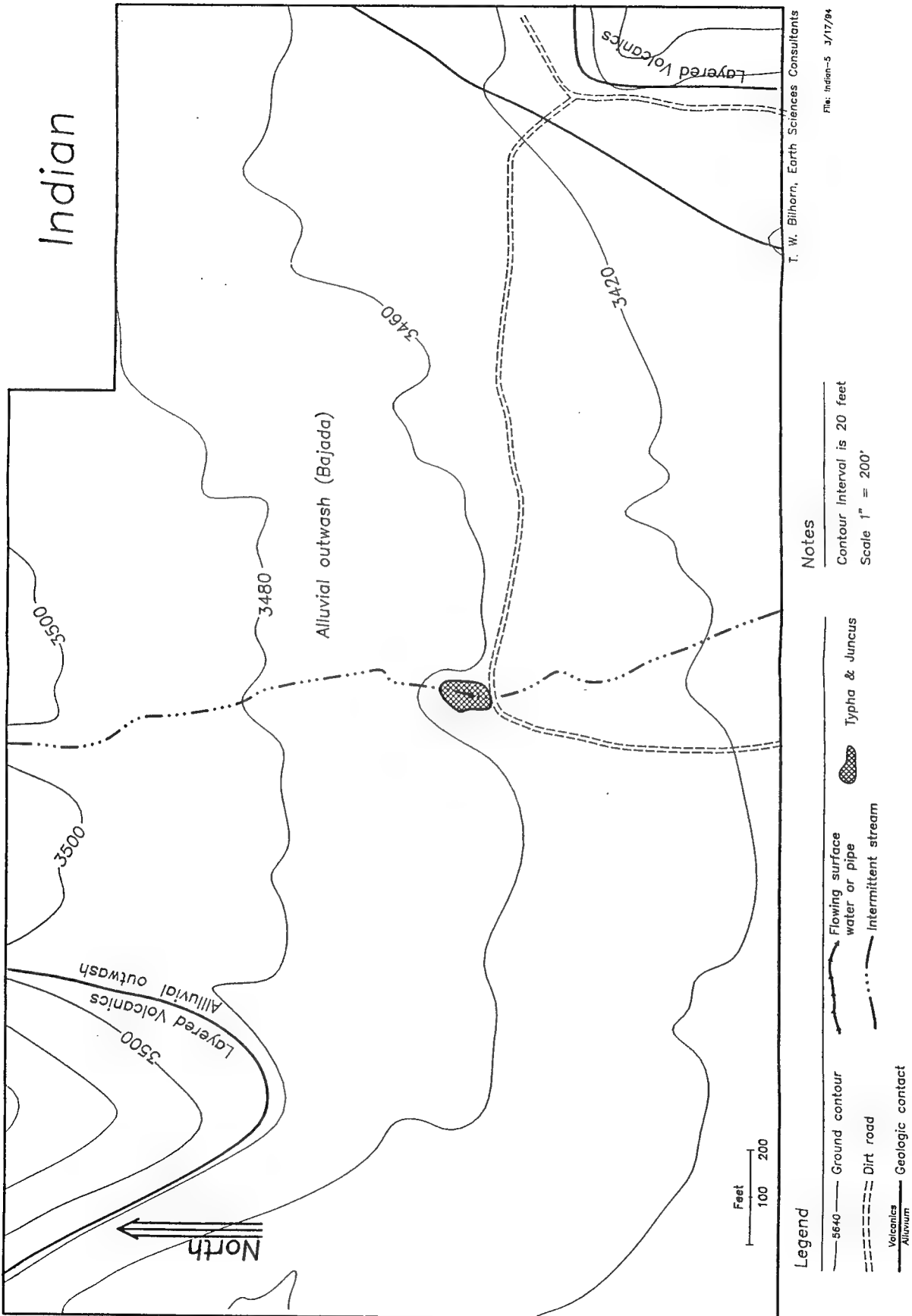
## Notes

Contour Interval is 10 meters

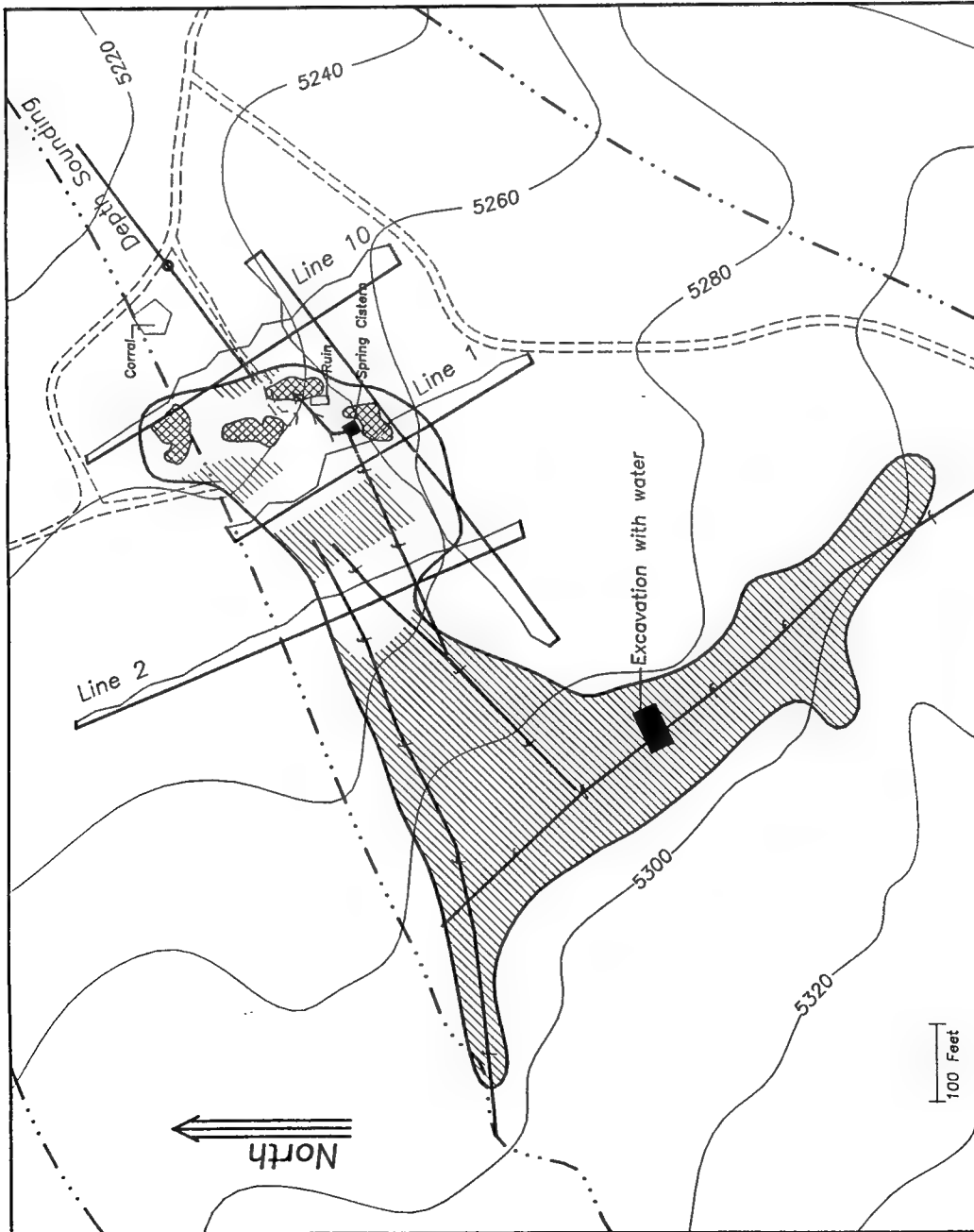
Scale 1" = 200'

File: Hidden-4 3/17/94

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# Indian Gardens



## Legend

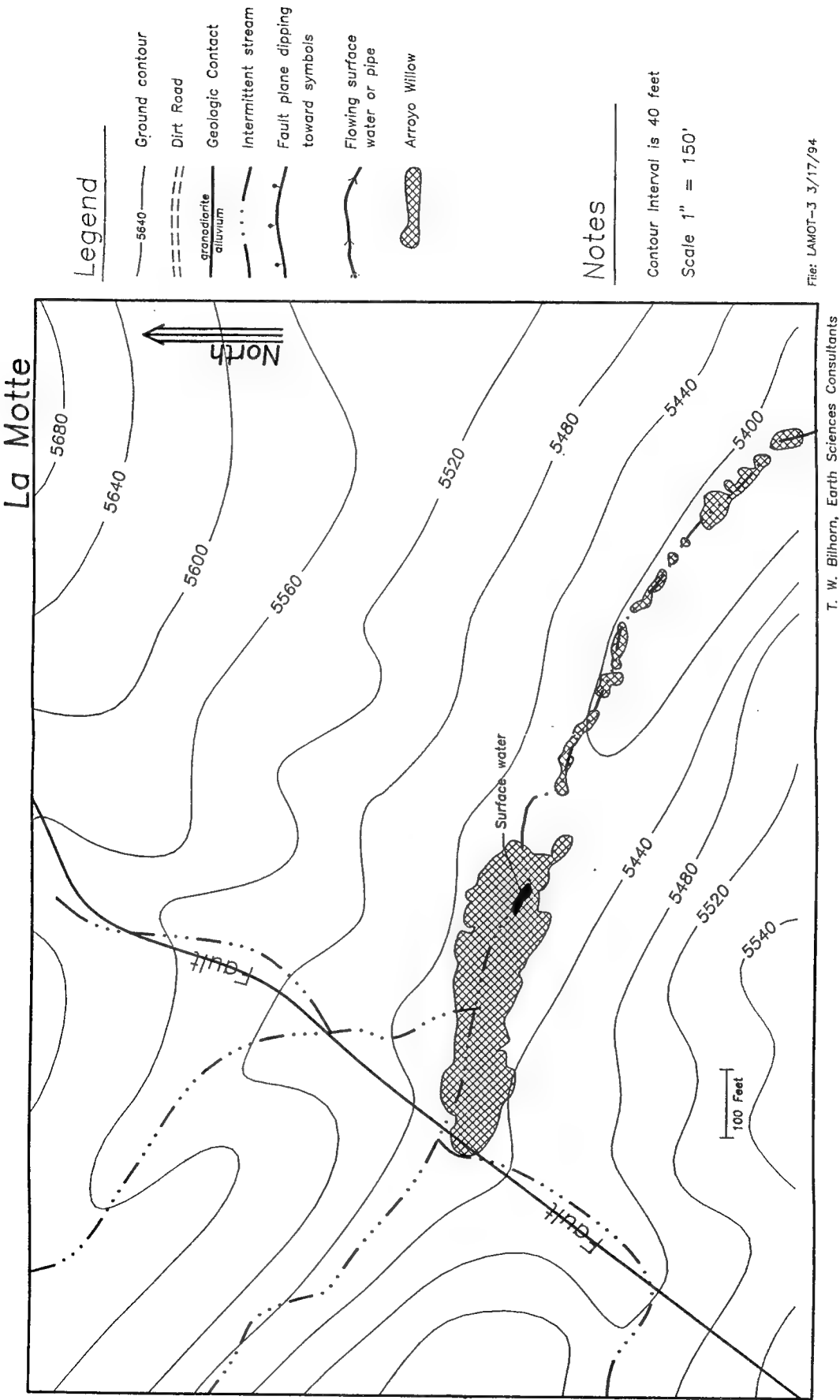
- 5640 — Ground contour
- - - - - Dirt road
- granodiorite  
— Alluvium — Geologic contact
- Intermittent stream
- Fault plane, dipping toward symbol
- Flowing surface water or pipe
- Resistivity profile showing curve of resistivity
- Arroyo willow
- Area of seepage from fractures
- Fracture

## Notes

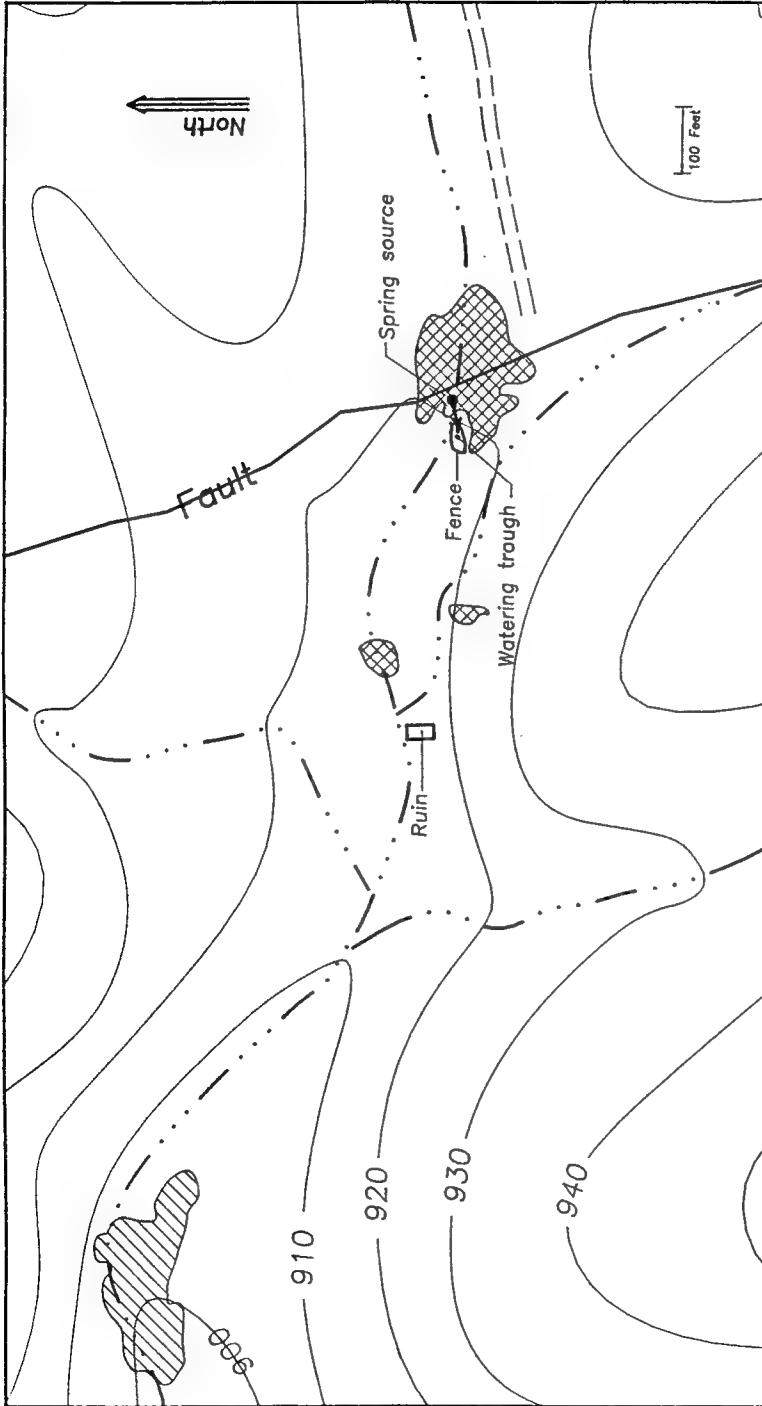
Contour Interval is 20 feet  
Scale 1" = 150'

File: INCDRD-S 3/17/94

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Layton



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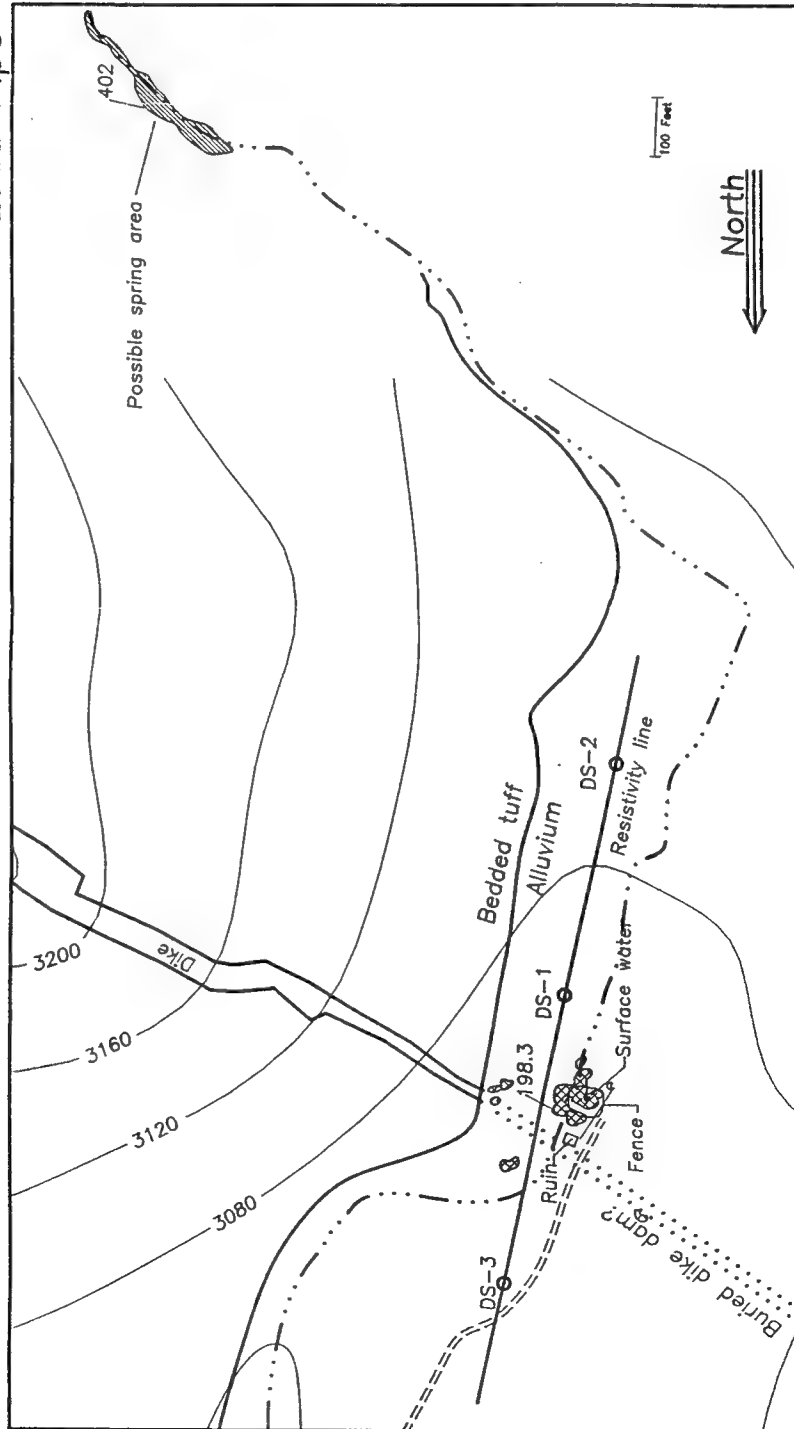
### Legend

- 5640 — Ground contour
- == == == Dirt Road
- granodiorite alluvium — Geologic Contact
- - - - - Intermittent stream
- Fault plane dipping toward symbols

### Notes

- Flowing surface water or pipe
- Squaw water weed
- Phreatophytes not ground verified
- Contour Interval is 10 meters
- Scale 1" = 100'
- File: Layton-3 3/17/94

# Lead Pipe



## Legend

- 5640 — Ground contour
- DIRT road
- Tuff  
Alluvium
- Geologic contact
- Intermittent stream
- Fault plane, dipping toward symbol
- Flowing surface water or pipe
- Resistivity line
- Squaw water weed
- Phreatophytes not ground verified

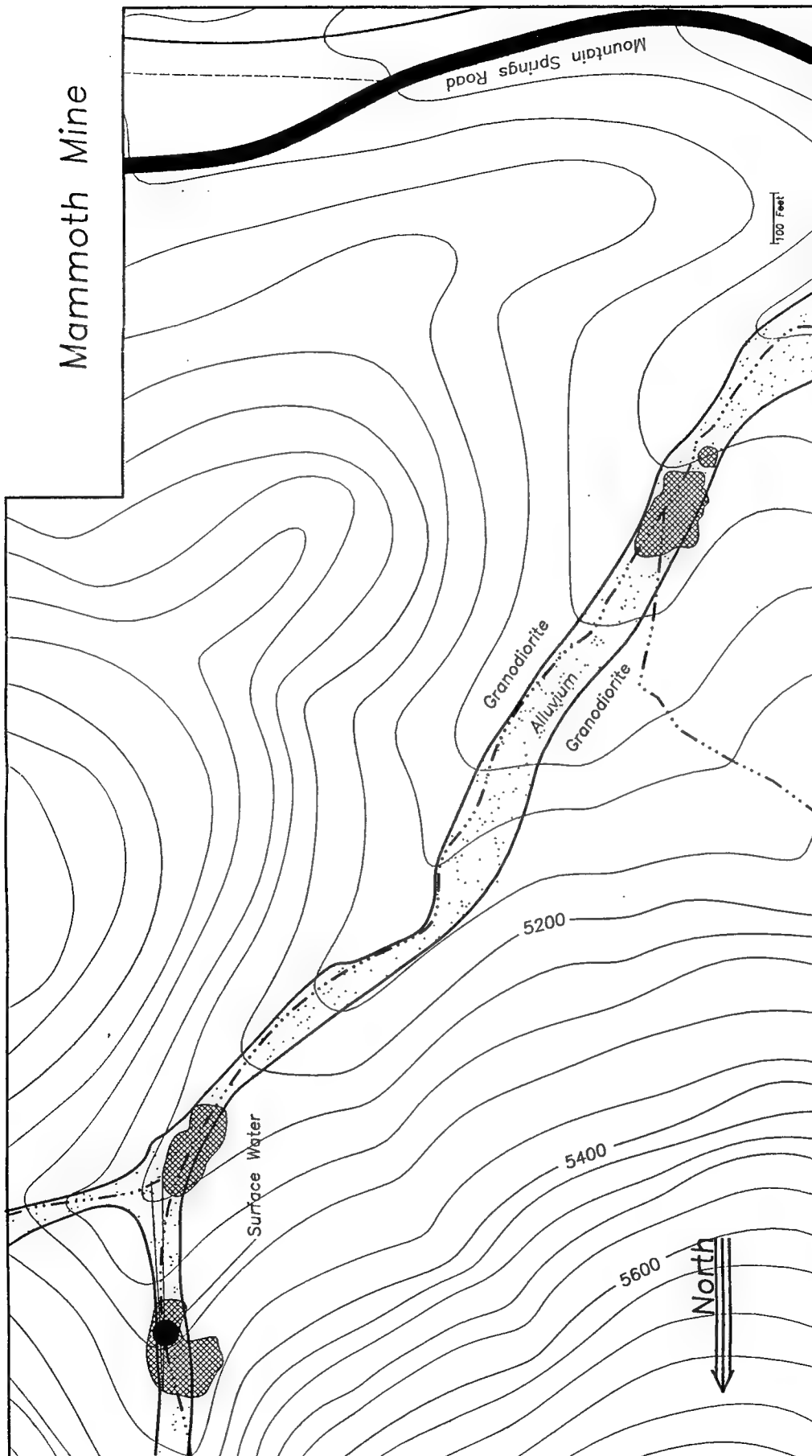
## Notes

Contour Interval is 40 feet  
Scale 1" = 150'

File: LDPIPE-5 3/17/94

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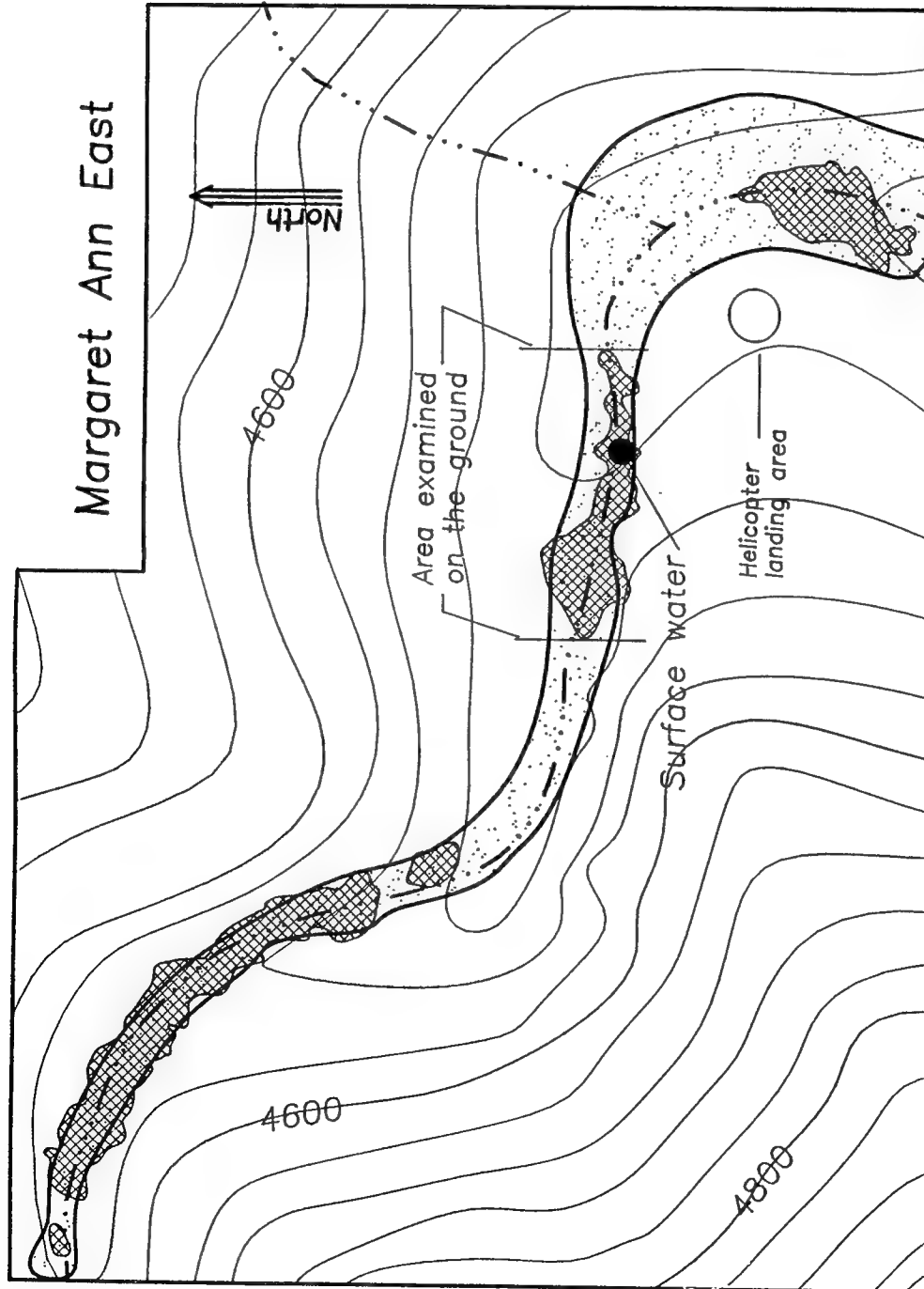
### Notes

Contour Interval is 40 feet

Scale 1" = 200'

### Legend

- 5640 ——— Ground contour
- ==== Dike road
- Geologic contact
- Granodiorite
- Alluvium
- Intermittent stream
- Flowing surface water or pipe
- Arroyo willow



### Legend

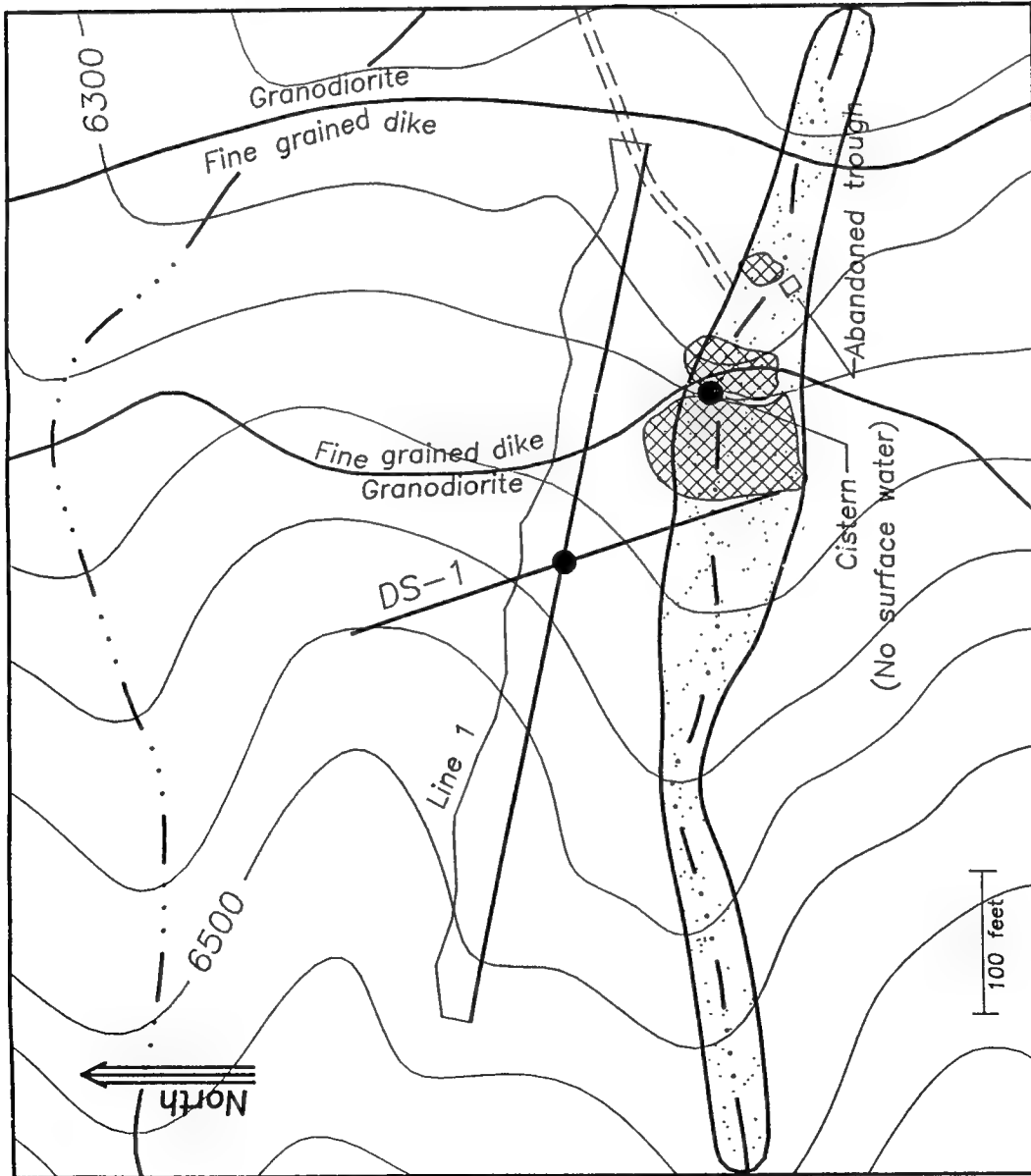
- 5840 — Ground contour
- == Dirt road
- granodiorite  
Alluvium
- Intermittent stream
- .-.- Fault plane, dipping toward symbol
- .-.- Flowing surface water or pipe
- Arroyo willow
- Alluvium

### Notes

Contour Interval is 40 feet  
 Scale 1" = 150'  
 File: M-Ann-3 3/17/94

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# Mariposa



## Legend

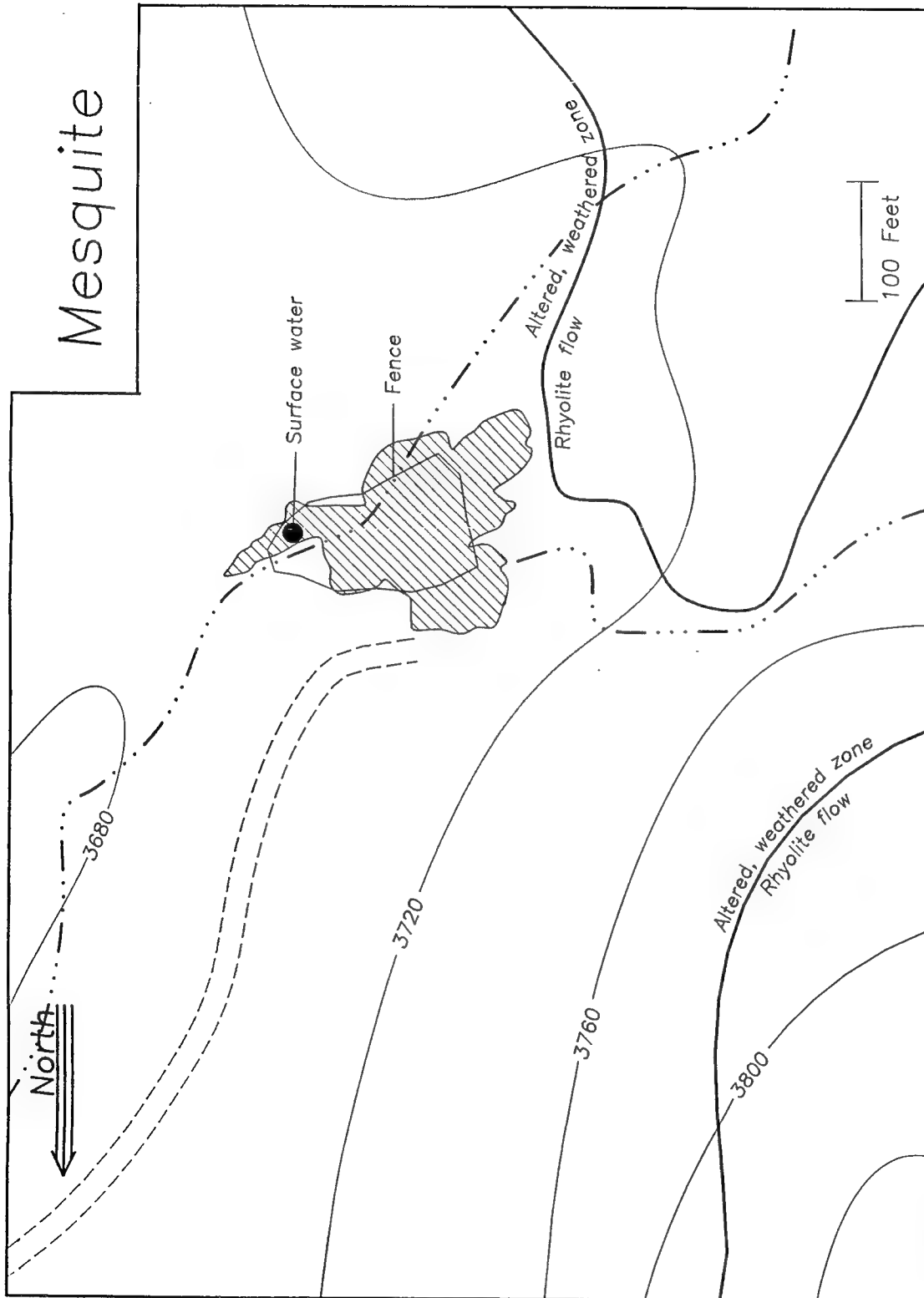
- 5640 — Ground contour
- == == == Dirt road
- granodiorite — Geologic contact
- Alluvium —
- ... Intermittent stream
- - - Fault plane, dipping toward symbol
- - - Flowing surface water or pipe
- - - Resistivity profile showing curve of resistivity
- Arrayo willow
- Alluvium

## Notes

Contour Interval is 40 feet  
Scale 1" = 100'

File: Marpos-5 3/17/94

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### Notes

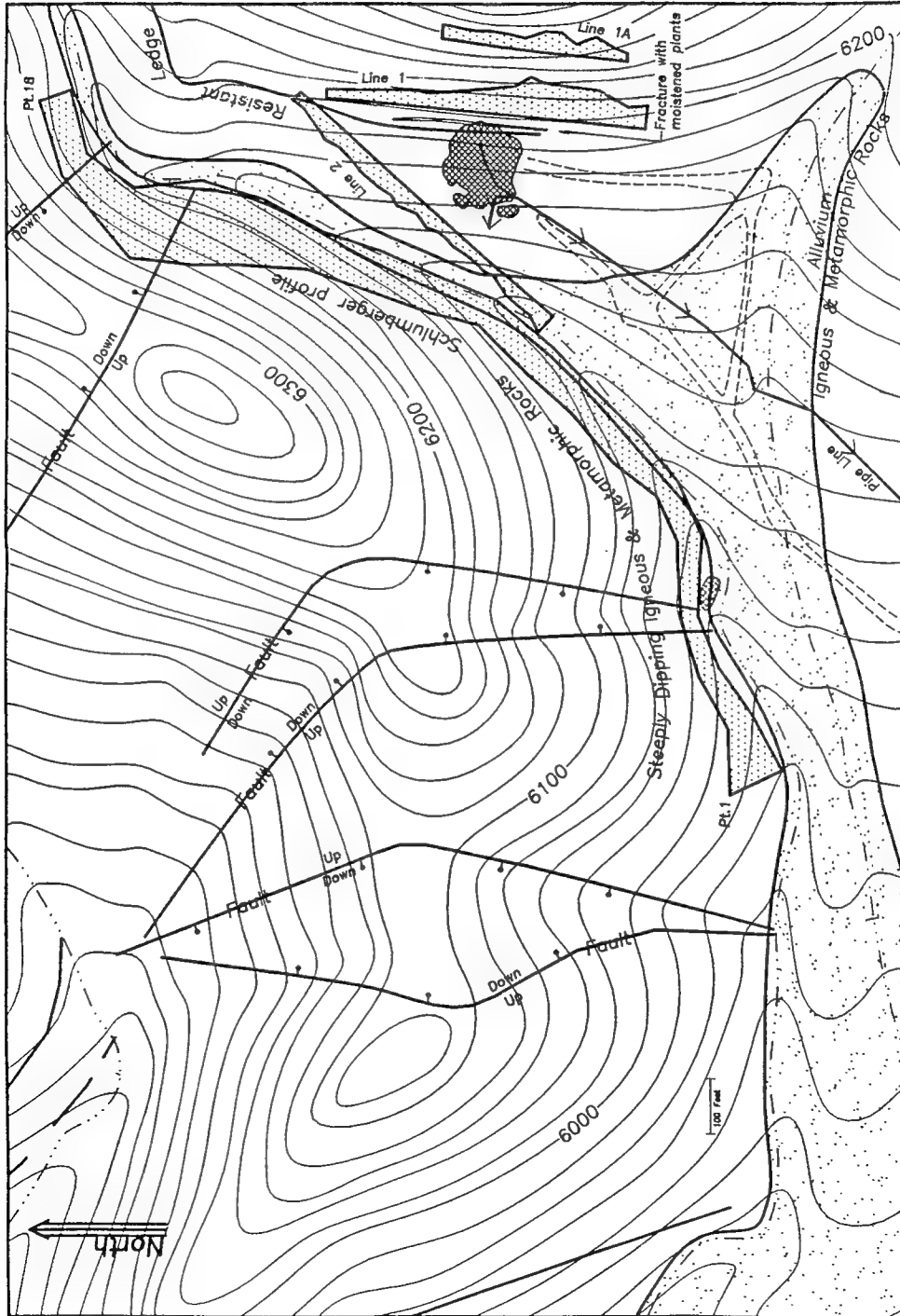
Contour Interval is 40 feet

Scale 1" = 50'

### Legend

- 5640 — Ground contour
- == == == DIRT road
- gradiolite Geologic contact
- Alluvium
- ... Intermittent stream
- Fault plane, dipping toward symbol
- Flowing surface water or pipe
- Resistivity profile showing curve of resistivity
- Mesquite (Prosopis glandulosa)

# Newhouse



## Legend

- 5840 — Ground contour
- == Dirt road
- gneissite  
alluvium Geologic contact
- Intermittent stream
- Fault plane, dipping toward symbol
- Flowing surface water or pipe
- Resistivity profile showing curve of resistivity
- Arroyo willow and Common Reed
- Alluvium

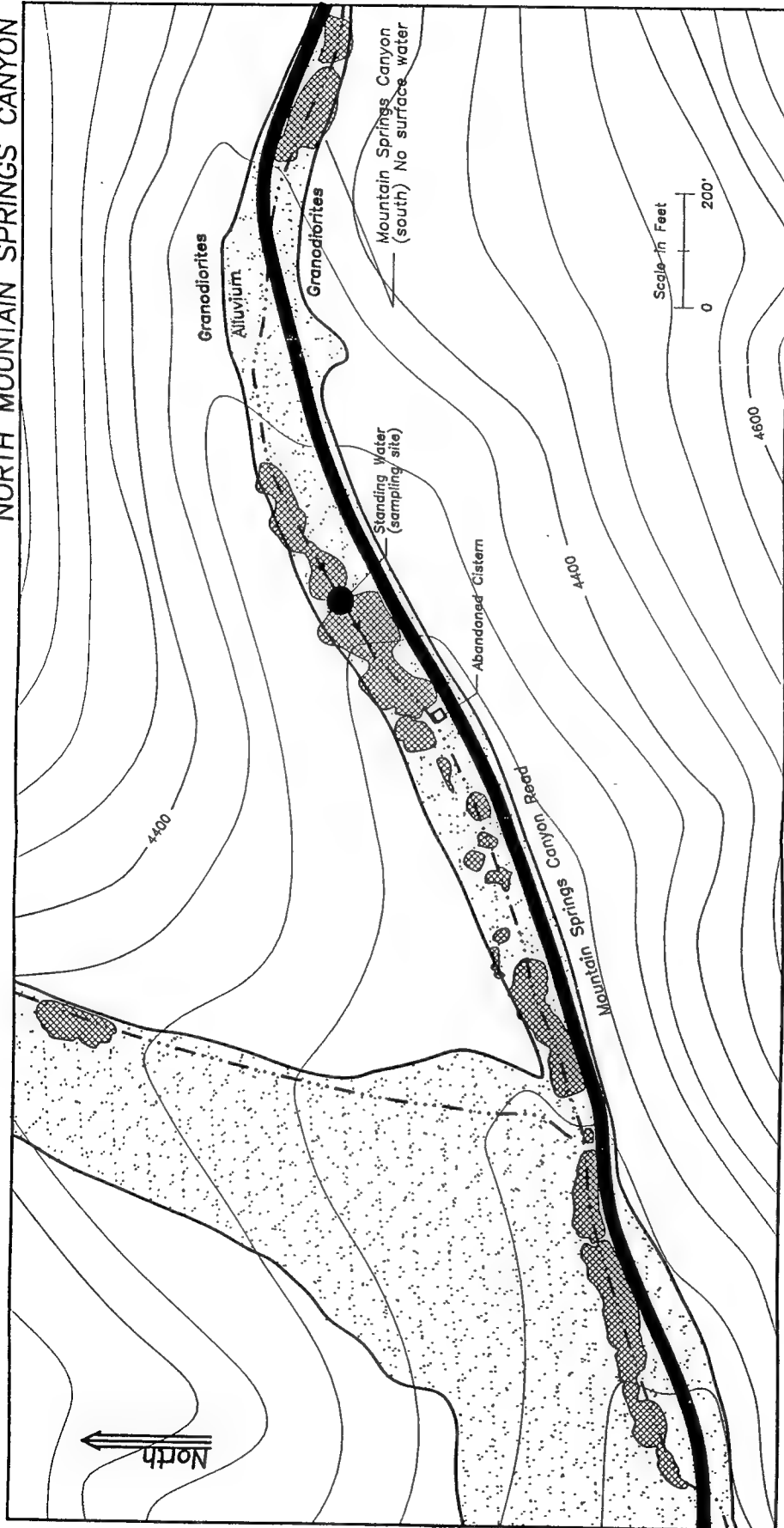
## Notes

Contour Interval is 20 feet  
Scale 1" = 200'

File: nas-4 3/17/94

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NORTH MOUNTAIN SPRINGS CANYON



Legend

- 5640 — Ground contour
- Dirt road
- granodiorite
- alluvium
- Geologic contact

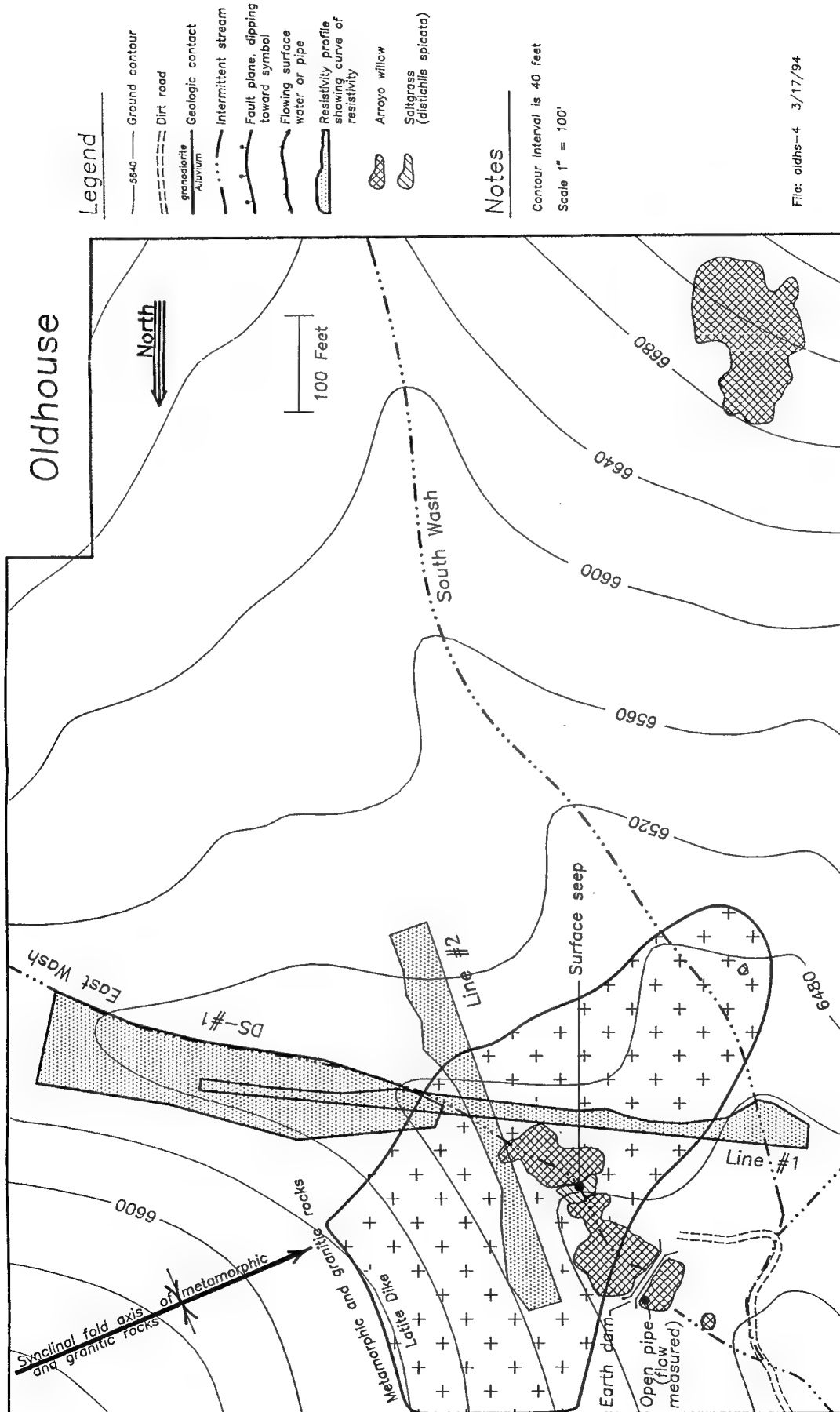
- Fault plane, dipping toward symbol
- Flowing surface water or pipe

- Arroyo willow
- Alluvium

Notes

- Contour Interval is 40 feet
- Scale 1" = 200'

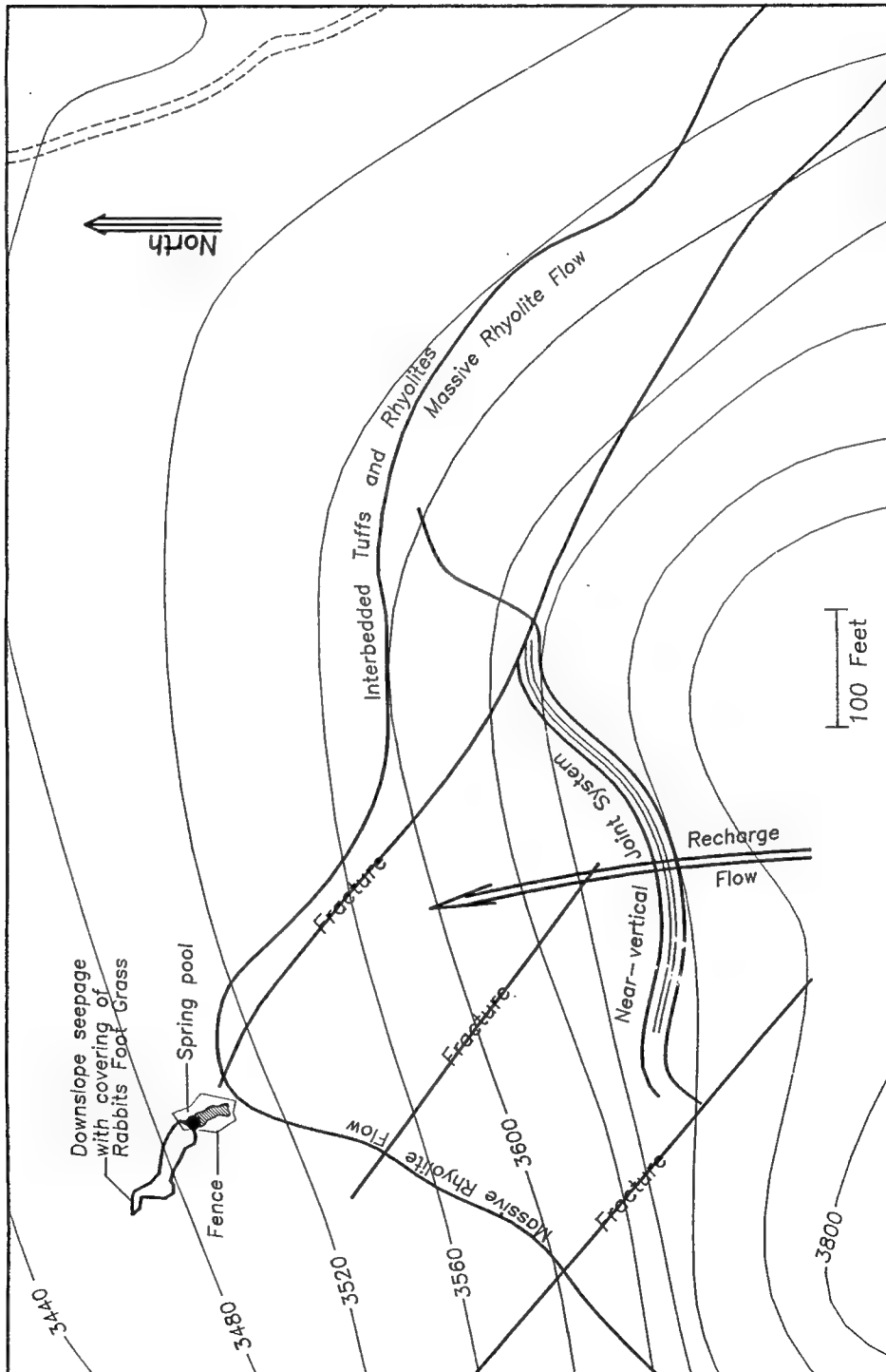
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File: nmtm-5 2/10/94



File: oldhs-4 3/17/94

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# Pink Hill



## Legend

- 5640 — Ground contour
- == Dashed line == Dirt road
- Geologic contact
- Intermittent stream
- Fault plane, dipping toward symbol
- Flowing surface water or pipe
- Resistivity profile showing curve of resistivity
- Typha

## Notes

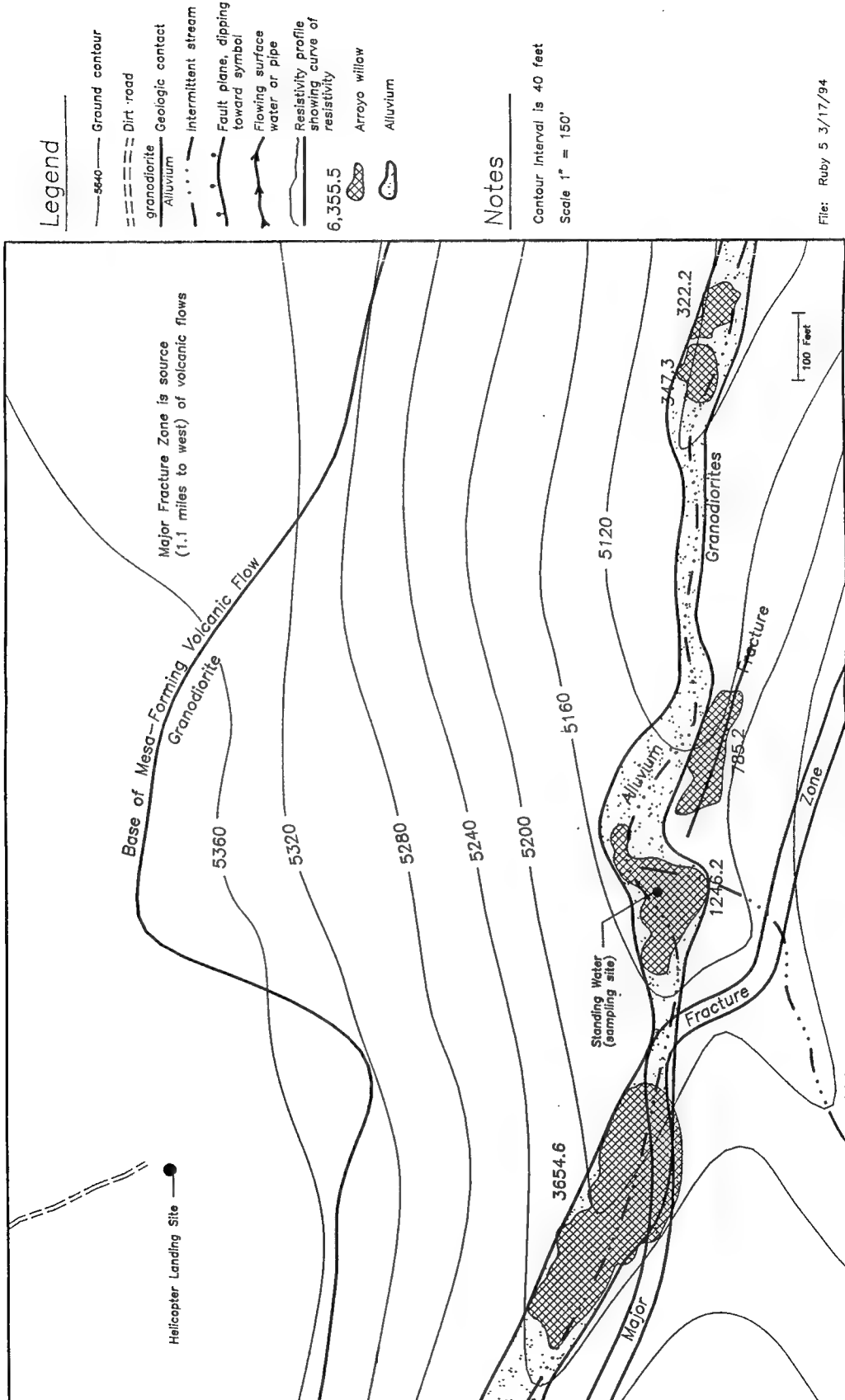
Contour Interval is 40 feet  
Scale 1" = 100'

File: pkhill-6 3/17/94

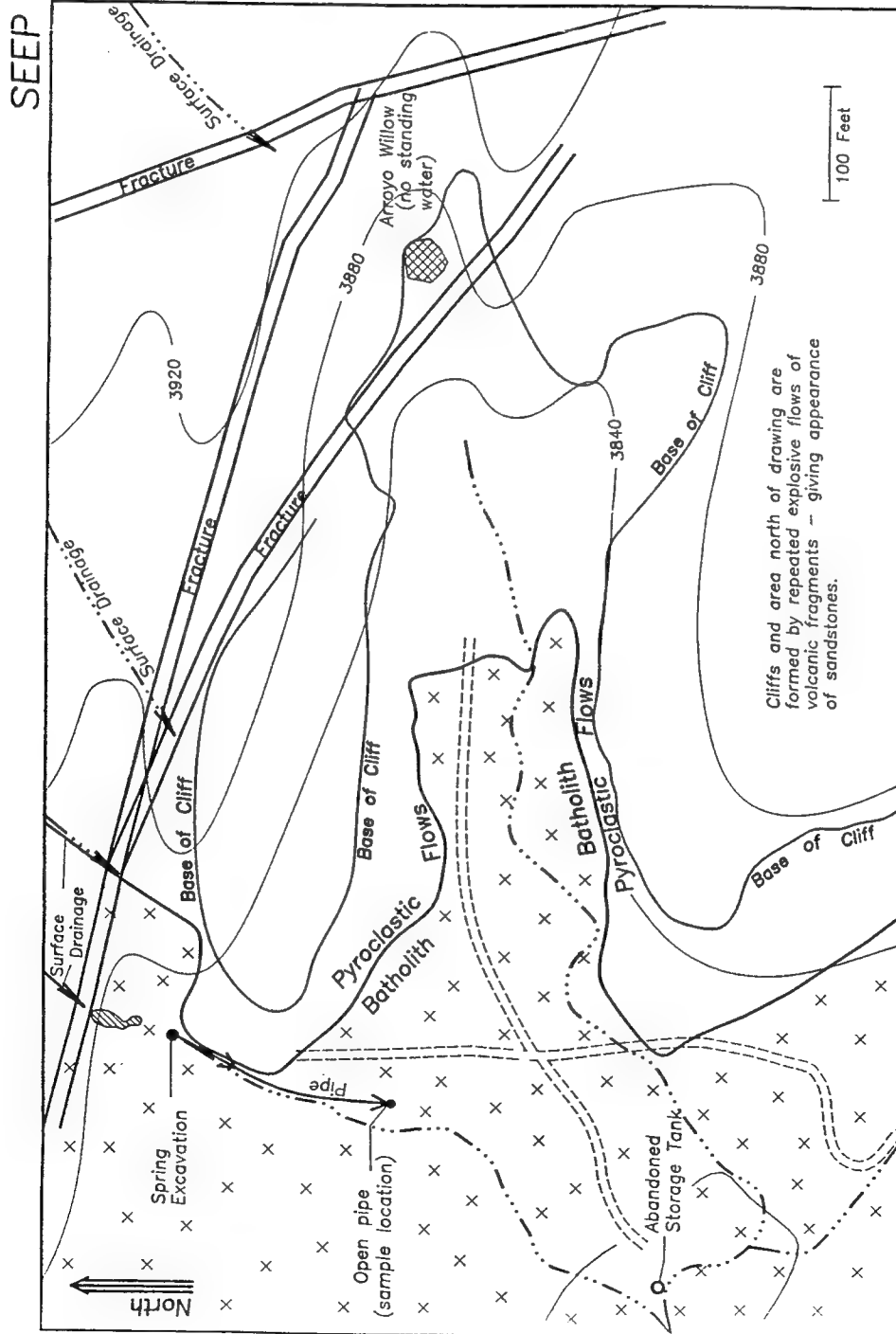
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# Ruby West



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**Legend**

- 5640 — Ground contour
- Dirt road
- granodiorite Alluvium --- Geologic contact
- Intermittent stream
- Fault plane, dipping toward symbol
- Flowing surface water or pipe
- Arroyo Willow
- Squaw Water Weed
- Granitic Rocks (highly chemically altered)

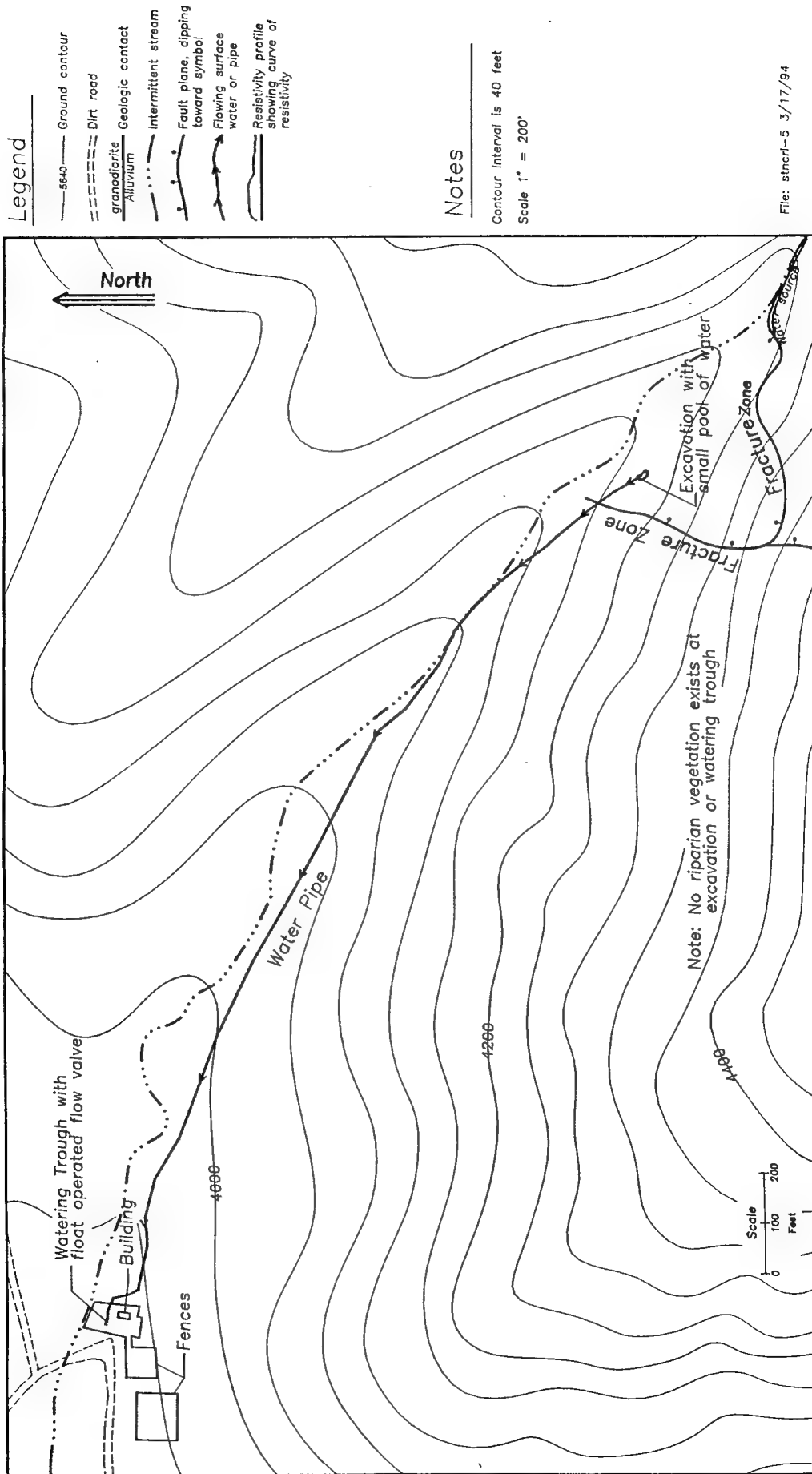
**Notes**

Contour Interval is 40 feet  
Scale 1" = 100'

File: Seep-6 3/17/94

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Stone Corral



Legend

- 5640 — Ground contour
- - - - - Dirt road
- granodiorite — Geologic contact
- Alluvium —
- . . . - Intermittent stream
- - - - - Fault plane, dipping toward symbol
- - - - - Flowing surface water or pipe
- - - - - Resistivity profile showing curve of resistivity

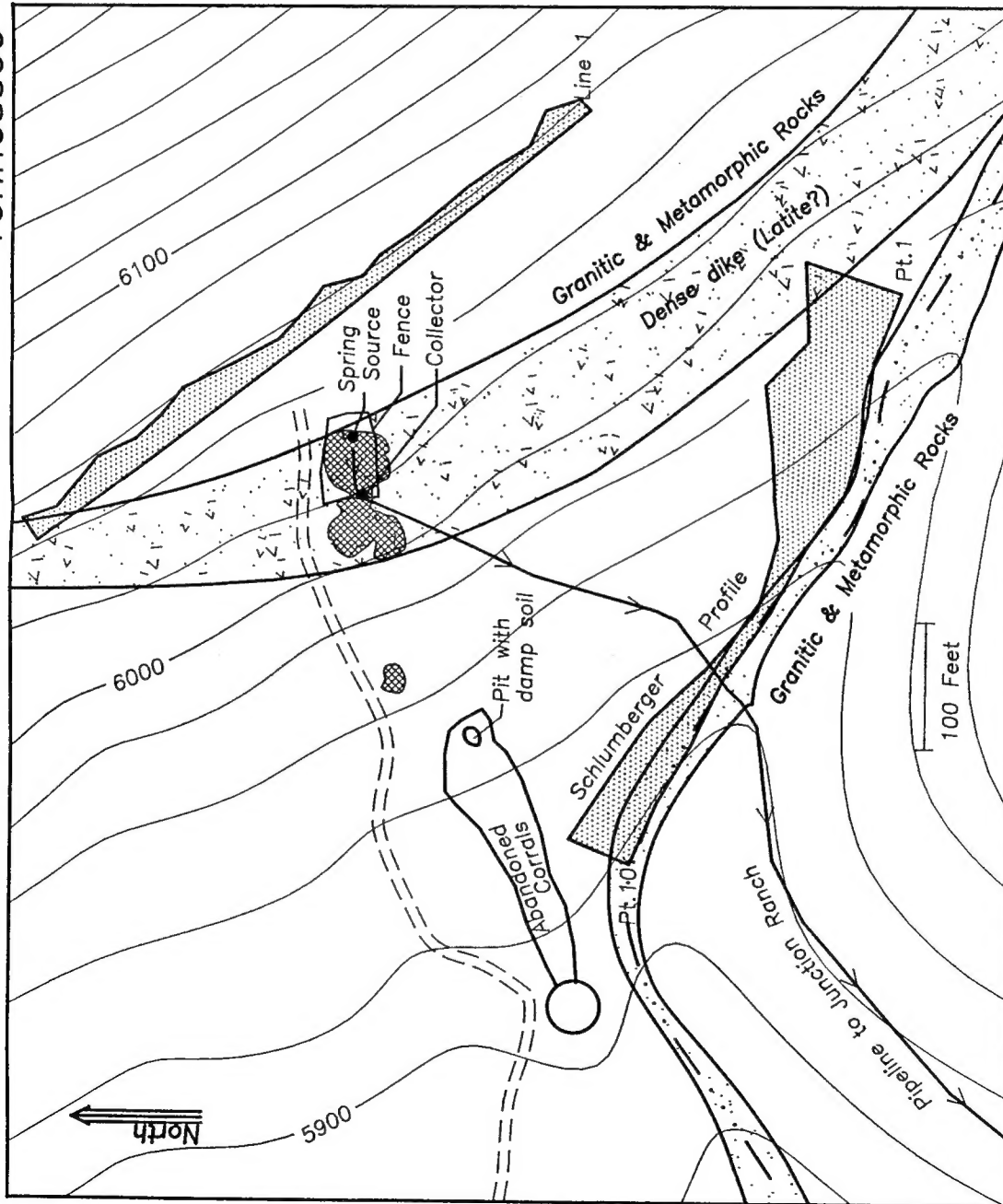
Notes

Contour interval is 40 feet  
Scale 1" = 200'

File: stncrl-5 3/17/94

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Tennessee



### Legend

- 5640 — Ground contour
- == == == Dirt road
- granodiorite — Geologic contact
- Alluvium —
- . . . - Intermittent stream
- . - . - Fault plane, dipping toward symbol
- - - - - Flowing surface water or pipe
- Resistivity profile showing curve of resistivity
- Arroyo willow
- Alluvium

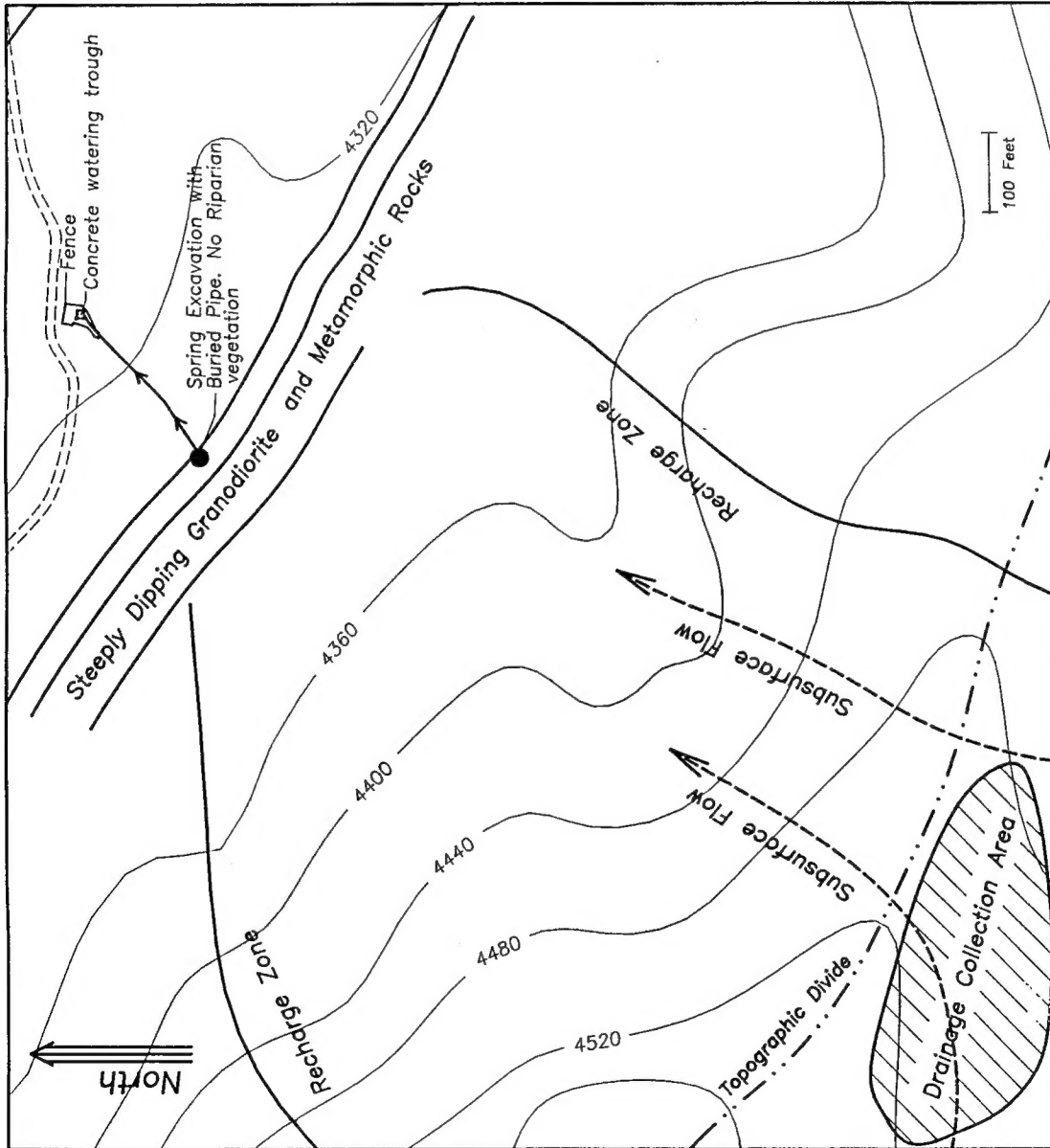
### Notes

Contour Interval is 20 feet  
Scale 1" = 100'

File: Tenes-6 3/17/94

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# Upper Tunnel



## Legend

- 5640 — Ground contour
- - - - - Dirt road
- granodiorite Alluvium
- . . . - Intermittent stream
- . - . - Fault plane, dipping toward symbol
- - - - - Flowing surface water or pipe
- - - - - Resistivity profile showing curve of resistivity

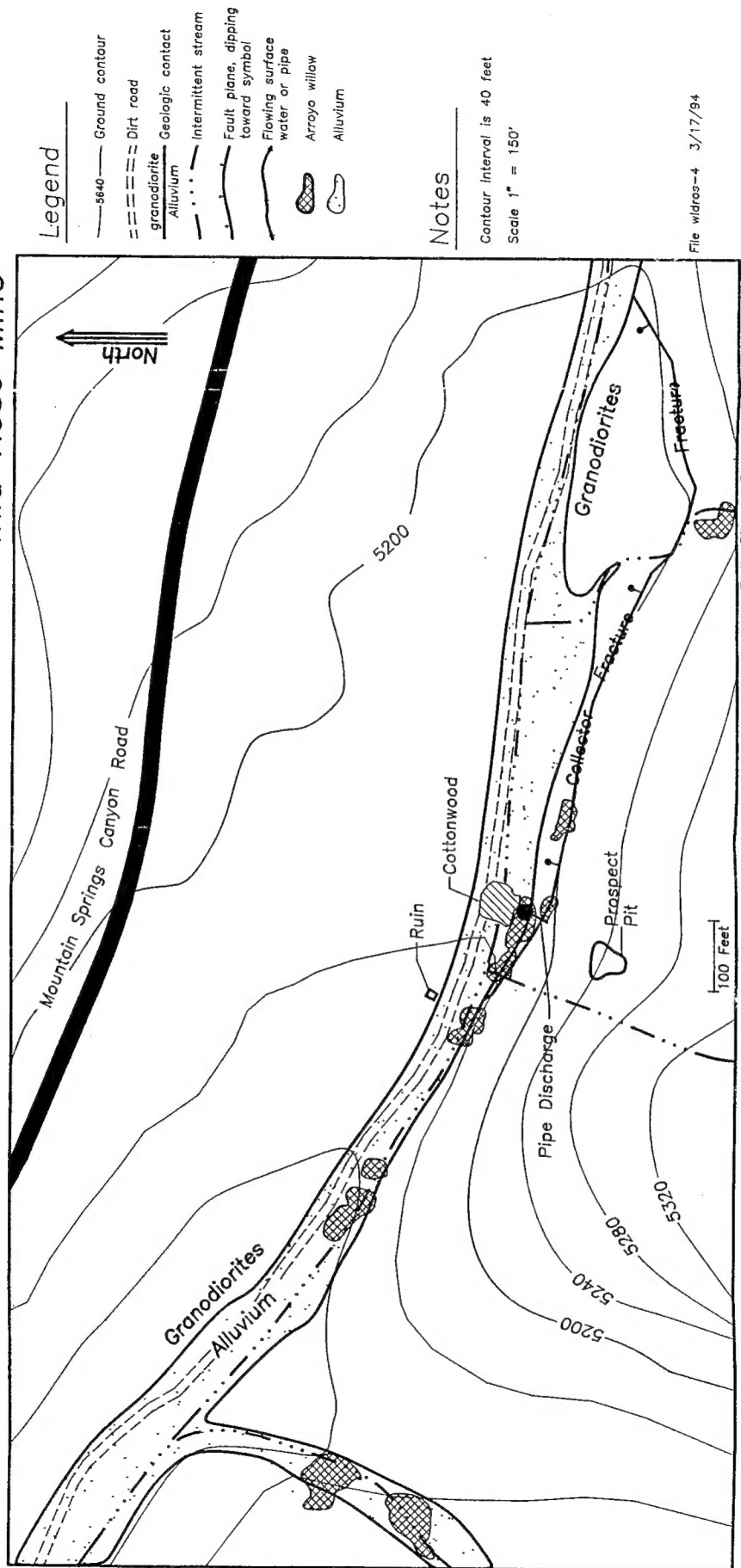
## Notes

Contour Interval is 40 feet  
Scale 1" = 150'

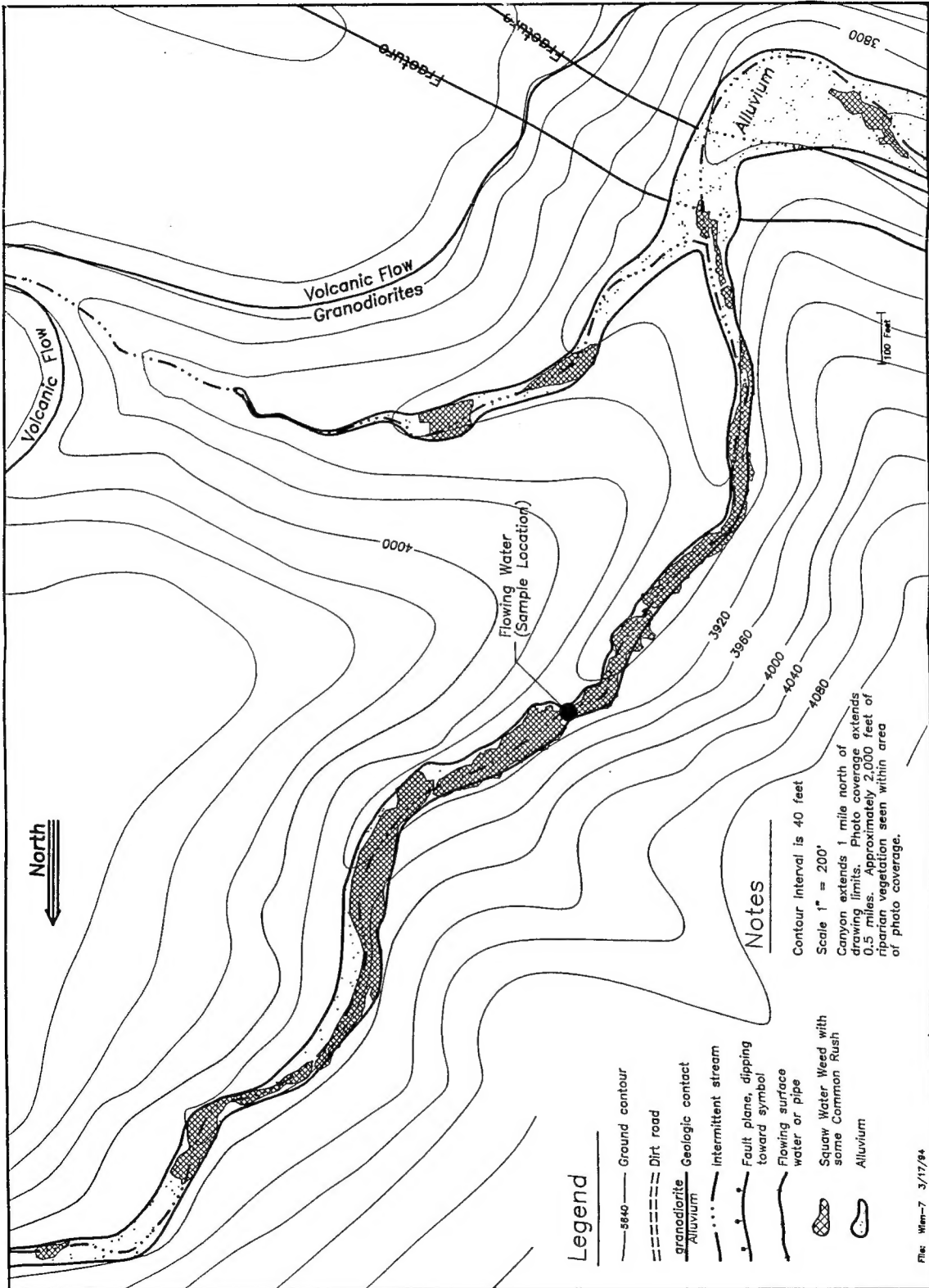
File: Uplum--4 3/17/94

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# Wild Rose Mine



Wilson Canyon



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File: Wm-7 3/17/94